Exploring the Science-Policy Gap with Australian Marine Scientists, Policymakers, and Interest Groups

By

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'Fishery management is an endless argument about how many fish there are in the sea until all doubt has been removed – but so have all the fish.'
- Sissenwine and Rosenberg, 1993.

DECLARATIONS

Declaration of Originality
This thesis contains no material which has been accepted for a degree or diploma by the University or any other institution, except by way of background information and duly acknowledged in the thesis, and to my knowledge and belief no material previously published or written by another person except where due acknowledgement is made in the text of the thesis, nor does the thesis contain any material that infringes copyright.

Jon Sumby

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The research associated with this thesis abides by the international and Australian codes on human research and the rulings of the UTas Social Sciences Human Research Ethics Committee.
Ethics reference number: H0008199

Jon Sumby

ABSTRACT

The 'science-policy gap' is a term that emerged during the 1990s and can be broadly defined as: 'The distance, or gap, between what the best available science advises and what policymakers actually decide'.

This thesis examines the development and current status of the science-policy gap, identifies the structure and primary causes of the gap, and suggests what can be done to close the gap.

Between 1663 and 2011, the causal elements of the science-policy gap are identified in the primary literature. This was done using a literature review that focuses on papers and articles that specifically mention the science-policy gap, forming a living discourse within the scientific and policymaking communities. The primary literature approach highlights the differing experience and perspectives of the science and policy communities and the efforts to 'close the gap'.

Global overfishing of marine life is a clearly recognized and critically important issue, for both marine ecosystems and for the millions of people who depend on marine protein as a primary food source. In response, there have been many policy instruments designed to control the extraction of marine living resources. However, the continuing experience of fisheries management policies worldwide is one of failure and the consequent collapse of marine fisheries and ecosystems.

This research refers to the issues around the management of marine living resources as examples of the science-policy gap, mainly relating to the management of ocean fisheries. The bulk of all fisheries are wild capture, exploiting marine populations that exist without human intervention as wild organisms within marine ecosystems. The tension between commercial exploitation of marine living resources and maintaining healthy marine ecosystems, now and into the future, is one that allows for the greatest expression of the science-policy gap. However, the discourse within the literature does not exclusively address marine systems, so examples of the science-policy gap occur in other disciplines (e.g. Health, early childhood development, geology, water resources).

A survey and interview series was done with Australian stakeholder groups engaged in the use of the marine environment. This was done to determine if there is any difference between what the primary literature considers being the primary causes of the science-policy gap and what day-to-day actors in the field believe.

The stakeholders were: Marine scientists; marine policymakers; the fishing industry; and marine environment groups. These people were drawn from throughout Australia and the results compared against the global discussion within the literature.

Analysis of the results found that there are two levels to the gap; a structural level experienced in the day-to-day relationship between science and policy, and a deeper, architectural, level that is the main cause of the gap.

Compared to the discourse in the literature, the Australian survey respondents and interviewees were far more aware of the deeper architectural level; putting it first and foremost and ranking other factors, such as uncertainty, as less important.

FOREWORD AND ACKNOWLEDGEMENTS

This thesis is dedicated to three special people:

- Ray Sumby; 1st June, 1945 – 8th November, 2011. He looked forward to seeing the finished thesis. He is sorely missed by me and those close to him.
- Linda McCrae, who was my best friend and sounding board. She died suddenly at the age of 26, just a week after my beloved companion of 16 years, Hobbe, died on the 18th January, 2012.

May you all rest in peace.

There are many routes one can take in choosing a research question for a PhD. Some are pre-packaged as part of the research direction of the supervisor, some extensions of a past honours thesis; others are the result of collaborative discussions between candidate and supervisor. My research question came about from my own experiences. It has, of course, been trimmed and moulded as part of the collaborative process between myself and my supervisor. The genesis of this research question came during my undergraduate degree in ecology with a major in marine ecology.

I noticed that the science being done, often with a clear message, was not appearing in the policy decisions, particularly concerning the open ocean. This was further reinforced during my time as the editor's assistant at the CSIRO journal *Marine and Freshwater Research*. There I read a great deal of science, particularly in the area of fisheries management from an ecological perspective, but again the research did not seem to be strongly reflected in policy decisions.

Two papers also sharpened my thinking; Frazer's 1991 paper, *Sea Turtle Conservation and Halfway Technology*; and Redford and Richter's 1999 paper, *Conservation of Biodiversity in a World of Use*. Both moved me to consider what I was seeing as a gap between science and policy. Alas, I soon found out that the 'science-policy gap' is a term becoming increasingly common.

I give my thanks and deepest appreciation to my supervisor, Assoc. Prof. Marcus Haward, for taking me on for this research and for his unstinting support, advice, encouragement and enthusiasm for this project. As well, I thank Linda McCrae and Alan Burbidge for their support and encouragement and to the survey focus group for their reviews and suggestions, particularly Sylvie Shaw. I would be remiss if I did not also acknowledge the generous effort made by the 235 people who took the time to complete and return my survey and also the eight key people who accepted my request for an interview.

My love and gratitude goes to my family for their support and encouragement and to my friends for much needed escapes. Finally, I could not have done this without my ever present and faithful Jack Russell, Hobbe-Horse, whose need for walks and play kept my feet on the ground.

A Note on Grammar

Within the primary literature, the noun compound words 'policymaker' and 'decision-maker' appear in a variety of forms; 'policy maker', 'policy-maker', 'policymaker' and ditto for the word 'decision-maker'. I use the latter for these reasons: The Australian Government Publishing Service's *Style Guide* advises that hyphenation should be only used to clarify meaning or where similar letters could cause difficulty in reading. *Fowler's Modern English Usage* concurs, '…the hyphen is not an ornament but an aid to being understood and should be employed only when it is needed for that purpose'. *Fowler's* quotes Sir Winston Churchill; 'One must regard the hyphen as a blemish to be avoided wherever possible'. Finally, the *Oxford English Dictionary* defines the words solely as 'policymaker' and 'decision-maker'.

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ACRONYMS

AAD – Australian Antarctic Division
AAAS – American Academy for the Advancement of Science
AAS – Australian Academy of Science
ABARE – Australian Bureau of Agricultural and Resource Economics
AFMA – Australian Fisheries Management Authority
ALDFG – Abandoned, Lost or otherwise Discarded Fishing Gear
AMSA – Australian Marine Science Association
CCAMLR – Commission for the Conservation of Antarctic Marine Living Resources
CCSBT – Convention for the Conservation of Southern Bluefin Tuna
CEO – Chief Executive Officer
CITES – Convention on the International Trade in Endangered Species
COP9 – Conference of Parties [9^{th}] [of CITES]
CPUE – Cost Per Unit Effort
CRC – Co-operative Research Centre
CSIRO – Commonwealth Scientific Industrial Research Organisation
CTD – Conductivity, temperature, depth
DAFF – Department of Agriculture, Forests and Fisheries [Australia]
DEH – Department of Environment and Heritage

DK – Don’t Know
DPAC – Department of Premier and Cabinet
EBM – Ecosystem Based Management
EEZ – Exclusive Economic Zone
EPA – Environment Protection Agency
EPBC – Environment Protection and Biodiversity Conservation [Act]
ERS – Ecologically Related Species
EU – European Union
FDA – Food and Drug Administration (US)
ICCAT – International Commission for the Conservation of Atlantic Tunas
ICES – International Council for the Exploration of the Sea
IOTC – Indian Ocean Tuna Commission
IPCC – Intergovernmental Panel on Climate Change
IUCN – International Union for the Conservation of Nature
IUU – Illegal, Unreported and Unregulated [fisheries]
IWC – International Whaling Commission
MPA – Marine Protected Area
MSY – Maximum Sustainable Yield
NPF – Northern Prawn Fishery
OED – Oxford English Dictionary
PNG – Papua New Guinea
RFMO – Regional Fisheries Management Organisation
RMP – Revised Management Procedure
SC – Scientific Committee
SBT – Southern Bluefin Tuna
TAC – Total Allowable Catch
UCS – Union of Concerned Scientists
UNCLOS – United Nations Convention on the Law of the Sea
UNEP – United Nations Environment Program
UTas – University of Tasmania
WCPFC – Western and Central Pacific Fishery Commission

DEFINITIONS

For the purpose of this thesis:
BYCATCH means catch from fisheries that is either unused or unmanaged (Davies et al., 2009).
FISHERIES means all types of marine capture fishing for all wild marine resources.
FISHERIES MANAGEMENT means the management of fisheries.
OVERFISHING means the harvesting of a fish population at a rate greater than the population can replenish itself through growth and reproduction. (Rosenberg, 2003).
POLICY means instruments for fisheries management, bycatch reduction, ecologically related species, and ecosystem protection.
POLICYMAKER and **DECISION-MAKER** are defined by the comment made by *GH*; the Director of a major Australian Commonwealth science research and policy organisation with an ocean science focus:

> I think policy’s made at all different levels. … a policymaker is somebody that makes a decision, that actually has an impact on what somebody else does. I don’t really see the difference between the decision-maker and the policymaker. There’s a difference between a policy adviser and a decision-maker. But all policy advisers [are] doing is framing a set of arguments.

Introduction

The objective of this thesis is straightforward: To resolve the fundamental causes of the science-policy gap which is defined as the distance, or gap, between what the best available science advises and what policymakers actually decide. The science-policy gap is a causal element in overfishing. There are other contributing factors to overfishing, but I maintain that the key, almost over-riding, element is the science-policy gap.

It is easy for a thesis to balloon out of control as every last sub-topic is explored. Here, I keep a close focus on the science-policy gap, staying as much as possible in relation to marine capture fisheries. There are closely allied topics; such as Science and Technology Studies and the 'politicization of science and the scientification of politics', but these are whole and different topics to that which I am examining.

My approach is essentially an ethnographic study; I propose no theoretical *praxis* and avoid any particular framework or perspective (e.g. Gramiscian political theory). I stay matter-of-fact in the hope that practising scientists and policymakers will be better able to draw understanding and insight from this work, rather than have a piece laden with jargon and theory possibly outside their knowledge. Instead, I have investigated the literature, working scientists, policymakers, and stakeholder groups. From this I draw out the critical elements of the science-policy gap as experienced by these groups and develop a 'map' of the gap. In doing so, I derive the main causes of the gap; the underlying elements that drive it and thus are fundamentally at the root of overfishing.

I do this first, in Chapters One and Two, by taking an historical overview of the science-policy gap as it first appears and develops in the primary literature. The primary literature was chosen as it represents the living discourse within the science and policy communities, rather than academic books somewhat divorced from the contemporaneous *milieu*. I make use of extensive quotations to draw out the perspective of authors past and to give context to the topic and show how similar concerns echo across time and to let these authors speak unhindered and originally. Chapter One is structured chronologically to give the reader an understanding of the development of the gap; Chapter Two continues this but introduces a thematic aspect to delineate the major directions that the discussion follows post-1990.

Then, in Chapters Three and Four, I surveyed the workers involved daily in the science-policy gap. The survey went to these people as, in my knowledge and experience, sending a survey to a CEO or Director usually encounters their personal secretary who is likely to filter out a survey instrument as a waste of the CEO/Director's time. Instead, I extended a personal invitation for an interview to a limited number of these individuals, those working at top of their organisational tree. I had a 100% success rate for this as the science-policy gap is definitely an issue of interest, or concern, to them. This means that the survey instrument draws from the knowledge of 'coal-face' workers who experience the interface between science and policy as they work, while the interviews draw on the knowledge of people with experience of the science-policy gap both practically and politically at a high level of engagement.

In Chapter Five, I distil the primary literature, survey, and interviews to develop an overall perspective of the science-policy gap and cut to the heart of the gap. From this I derive some conclusions, principles, and directions for workers who face the gap, which I present in the conclusion. There are some ideas for further research resulting from this thesis and other issues that need further attention. But to begin, I present an overview of the anthropogenic pressures being placed on the ocean, to which overfishing is an extra stressor and contributes to the global decline of marine ecosystems.

Once I had a conversation with a marine ecologist working on the Wallace Line[1]. I asked her if she was beyond the reach of blast fishing[2] and she said that even there she could always hear it like distant thunder underwater as she did her research. As we talked, I asked her why a Swedish marine ecologist was here, in an extremely remote part of the world, and her reply has stayed with me. She said, 'In Europe we just study how dead the ocean is, but here there is *Life*!' That was twenty years ago and the situation has not changed.

Ocean ecosystems are declining rapidly and many species and ecosystems have declined in the 45-99% range (see Table A1). Over 90% of predatory fish have disappeared globally (Myers and Worm, 2003). New fish populations may well be exhausted by 2020, which means that the serial depletion of fish populations ('boom, bust and move on' fishing) will not continue and a global collapse of fisheries is estimated, at the earliest, by 2048 (Froese and Kesner-Reyes, 2002; Worm et al., 2006; Froese et al., 2009), although this has been disputed. The cause of this destruction is easy to identify: Overexploitation. The reasons for this overexploitation and why it still happens is the subject of much interest. Industrial fishing methods are a main driver, but recreational and artisanal fisheries also play a part (McPhee et al., 2002); with the pattern of depletion being scalar, as Worm et al. (2006) found the same pattern from local (recreational and artisanal) to global shelf and oceanic fisheries. Now ocean ecosystems are endangered, with coastal and shelf systems the most endangered (Jackson, 2008; Jackson and Jacquet, 2011).

We have sophisticated and large scientific knowledge bases and extensive research and analytical capacity. For example, the EU bases its Common Fisheries Policy on the work done by the International Council for the Exploration of the Seas (ICES) which has over 120 years worth of research data, yet overfishing continues. Globally, there are large and expert fishery research institutions; ICES in Europe, the National Marine and Fisheries Service in the US, and in Australia the CSIRO, to name a few. Yet marine fish populations continue to be overfished, with marine fish abundance declining globally by an average of 38% since 1970 (Hutchings et al., 2010).

Humans have always fished the sea and the first identifiable depletion by overfishing occurred about 125,000 years ago when the giant clam (*Tridacna costata*) disappeared from the Red Sea (Richter et al., 2008). Starting at *c.* AD 1000, new methods of fishing in Europe began to have direct effects on ocean ecosystems (Barrett et al., 2004; Roberts, 2007). This impact accelerated in the late Nineteenth century with the invention of the steam engine, leading to the destruction of whale populations, shelf fisheries, and oyster beds, to name a few. Globally, the exploitation and destruction of the ocean environment began in the 1950s, with the expansion of trawl and seining fisheries (Fig. A1).

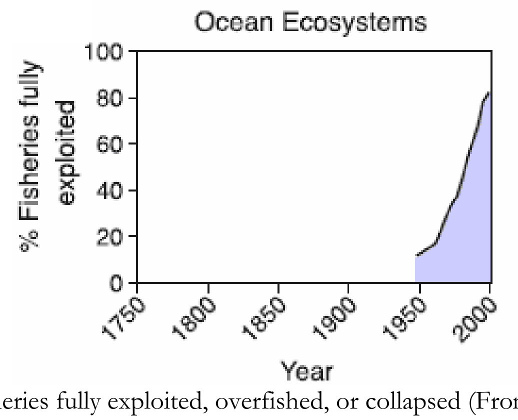

Fig. A1 Percentage of global fisheries fully exploited, overfished, or collapsed (From; Steffen et al., 2011).

[1] The Wallace Line: A biological divide between Asian and Australasian ecologies, named in honour of Alfred Russell Wallace who also conceived the theory of natural selection, but let Darwin publish first.

[2] Blast fishing: Fishing on coral reefs using explosives that destroy the reef and has a large bycatch. About 40% of fishing in Indonesian waters is blast fishing and the practice is moving into the Pacific and Indian oceans.

Table A1 Percent loss of fauna and flora in different locations. Starting dates are from the beginning of the data time series, except for depletions estimated from the pristine, unexploited condition. SAV* = Submerged aquatic vegetation. (From; Jackson, 2008)

Taxon	Starting date	Location	% loss
Estuaries and coastal seas			
Large whales	Pristine	Global	85%
Small whales	Pristine	Global	59%
Pinnipeds and otters	Pristine	Global	55%
Sirenia	Pristine	Global	90%
Raptors	Pristine	Global	79%
Seabirds	Pristine	Global	57%
Shorebirds	Pristine	Global	61%
Waterfowl/waders	Pristine	Global	58%
Sea turtles	Pristine	Global	87%
Diadromous fish	Pristine	Global	81%
Groundfish	Pristine	Global	62%
Large pelagics	Pristine	Global	74%
Small pelagics	Pristine	Global	45%
Oysters	Pristine	Global	91%
Mussels	Pristine	Global	47%
Crustaceans	Pristine	Global	39%
Other invertebrates	Pristine	Global	49%
Seagrass	Pristine	Global	65%
SAV*	Pristine	Global	48%
Wetlands	Pristine	Global	67%
Large carnivores	Pristine	Global	77%
Small carnivores	Pristine	Global	60%
Large herbivores	Pristine	Global	63%
Small herbivores	Pristine	Global	54%
Suspension feeders	Pristine	Global	68%
Shelf and pelagic fisheries			
Large predatory fishes	1900	N. Atlantic	89%
Atlantic cod	1852	Scotian shelf	96%
Fish 4–16 kg	Pristine	North Sea	97%
Fish 16–66 kg	Pristine	North Sea	99%
Large predatory fish	1950s	Global	90%
Large pelagic predators	1950s	Tropical Pacific	90%
Fishery biomass	1959	Bohai Sea	95%
Coastal and pelagic sharks			
Hammerheads	1986	N.W. Atlantic	89%
White	1986	N.W. Atlantic	79%
Tiger	1986	N.W. Atlantic	65%
Carcharhinus spp.	1986	N.W. Atlantic	61%
Thresher	1986	N.W. Atlantic	80%
Blue	1986	N.W. Atlantic	60%
Mako	1986	N.W. Atlantic	70%
Coral reefs			
Live coral cover	1977	Caribbean	80%
Live coral cover	1977	Caribbean	93%
Live coral cover	1980–1982	Indo-West Pacific	46%
Diadema antillarum	1977	Caribbean	92%
Reef fish density	1977	Caribbean	90%
Green turtle	1700s	Caribbean	>99%
Hawksbill turtle	1700s	Caribbean	>99%
Goliath grouper	1956	Florida Keys	96%
Large carnivores	Pristine	Global	85%
Small carnivores	Pristine	Global	61%
Large herbivores	Pristine	Global	87%
Small herbivores	Pristine	Global	66%
Corals	Pristine	Global	61%
Suspension feeders	Pristine	Global	49%
Seagrasses	Pristine	Global	50%

In the late Nineteenth century there was a single oyster bed that covered over 24,000 square kilometres in the North Sea. This 'crusted' the seabed and raised biogenic reefs that were exposed at low tide. Those reefs had grown over the centuries and supported a rich and diverse benthic ecosystem of marine plants and animals, including lobsters; which, in turn, supported demersal and pelagic animal populations. The steam trawlers dragged up and destroyed this oyster bed in a couple of decades (Roberts, 2007) with the fisheries starting to collapse soon after (Christensen et al., 2003).

Today most of the North Sea benthos is depauperate, with every fishable square kilometre trawled at least twice a year (including wreck sites, like *HMS Victory* (Kingsley, 2009))[3]. The same happened in Chesapeake Bay (USA), where oyster beds filled this large bay and extended over three miles out to sea (Roberts, 2007; Lai and Christensen, 2009). Today there are no wild oyster fisheries, all oysters are brought to market from aquaculture: Oyster populations globally have declined by over 90% (Roberts, 2007; Jackson, 2008).

There is no lack of examples:

- The depletion of the blue whale from a population known to be once in the hundreds of thousands to, at most, 11,000 today;
- the Grand Banks cod, estimated to number over two billion fish in the 1960s to perhaps 60,000 tonnes thirty years later (Hutchings and Rangeley, 2011);
- to the critically endangered hawksbill turtle which once had a population of eleven million before being hunted for its shell, today the population is less than 30,000;
- post-World War Two Philippines, where the huge number of left-over explosive weapons led to the present blast fishing method that is common in Indonesia and is expanding across the Western Pacific and Indian Oceans;
- to the late-1960s observation by an American tuna fisher of the relationship between dolphin and tuna (still unexplained, but I tend toward the cooperative hunting hypothesis) led to the purse seining of dolphin to catch the tuna below, dolphins in the Pacific have not yet recovered;
- then to the 1950s observation by an American aquarium owner who found that cyanide used to kill algae in the tanks also stunned the fish, leading to the present widespread cyanide fishing on coral reefs throughout South East Asia;
- to the serial depletion of holothurians in southern Papua New Guinea and the collapse of the white abalone (*Haliotis sorenseni*) population in California: The fishery collapsed within nine years but the decline continued, going from ~20,000 abalone per hectare to about one per hectare within two decades (Malakoff, 1997).

These are just some fisheries set against a background of general global ocean ecosystem decline caused by trawling, seining, longlining, driftnetting (banned globally since 1992 but still an active fishing method, particularly in the Indian Ocean), pair-trawling, finning and related industrial fishing methods. To catch more of what less is left fishing boats have become bigger with the 'super-trawler' appearing more often in global fishing fleets. The *Northern Leader*, a 'super-longliner', with an 'astonishing' capacity of 76,800 hooks set per day is due in the North Pacific in 2013 (Anon, 2012); while the *Albatun Dos* is one of the largest three purse-seine fishing ships operating in the world. The other two vessels (*Albatun Uno* and *Albatun Tres*), are also owned and operated by the same company, Albacora SA. These three ships work the Indian and Pacific Oceans to supply European consumers demand for canned tuna (Fig. A2).

Environmental threats from pollution, loss of habitat, bycatch, illegal fishing and lost fishing equipment compound the problems. These will be briefly outlined below to give a broader picture of the impact of human activities on the ocean environment and that they also complement, or exacerbate, the effects of overfishing.

[3] Wrecks are deliberate targets for fishing as they are biological 'oases', with larger and more numerous fish. Wreck fishing began in the 1960s and continues today, causing damage to the archeological value of the wrecks and depletion of the associated marine life. Undiscovered wrecks are actively sought.

Fig. A2 The *Albatun Dos*. This 116 m, Spanish owned purse seine vessel can take up to 3,000 tonnes of tuna in a single voyage and is one of the largest vessels of its type; the other two are the *Albatun Uno* and the *Albertun Tres*. The ship was built in 2004 with a € 4.9 million (~AU$ 6.12 million) taxpayers subsidy from the EU; the subsidies for the other two vessels are unknown (Mulvad and Thurston, 2009). (Image: Clipper/CCLic 2009)

Bycatch

Under a recently proposed definition; 'Bycatch is catch that is either unused or unmanaged', 40.4% of global trawl catch is bycatch (some 38.5 million tonnes) (Davies et al., 2009). The authors caution that this should be considered a minimum estimate of total global bycatch as they did not include longlining, gillnetting, pots, traps or artisanal fisheries. In Australia (see Fig A3), bycatch forms an estimated average of 24.6% of total catch (Kelleher, 2005). In broad terms bycatch has three main components:

1. Species that are caught and dumped at sea as they are unwanted by the fishing vessel.
2. Species that are not associated with the fishery but are caught by the gear (seabirds, marine mammals, sea turtles, corals, invertebrates, etc.).
3. Species that are caught and landed but are unwanted for market and dumped.

There are many subsets of bycatch: High-grading (dumping smaller, less valuable, fish of the target species in expectation of catching bigger fish of the same species); catching the wrong species for the fishing permit; quota discard (in multispecies fishing, if the quota for one species has been reached but not for another species the ship keeps fishing, dumping the fish for which it has reached quota until it reaches the quota(s) for the other species); the caught fish are damaged, etc.

Bycatch can affect commercial species, contributing to overfishing. For example, the Argentinean shrimp fishery of 50,000 tonnes annually is estimated to generate 365,000 tonnes of bycatch, of which 30,000-40,000 tonnes is hake, a valuable commercial fish and a fishery that almost collapsed in the late 1990s (Davies et al., 2009). Bycatch contributes to the depletion of marine species, the trophic downgrading of the ocean and alteration to the ecosystem function of the ocean (such as trophic cascades: Brierley, 2007; Myers et al., 2007).

Almost half the birds listed on the IUCN *Red List* as endangered are seabirds with fishing methods the threatening process (Anon, 2007; Croxall et al., 2012). Bycatch from longlining and trawling is estimated to kill over 100,000 albatross each year (see Fig. A4) while driftnetting, before it was banned, killed at least 500,000 seabirds each year (Trouwborst, 2008). Pelagic longlining alone killed 200,000 endangered loggerhead turtles (*Caretta caretta*) and 50,000 leatherback (*Demochelys coracia*) turtles annually in 2000, with the species declining by 80-95% in the last 20 years (Lewison et al., 2004). This doesn't just apply only to oceanic industrial fisheries; small scale fisheries off coastal Peru have a significant deleterious effect on loggerhead and leatherback turtles (Alfaro-Shigueto et al., 2011)

IUU fisheries

Illegal, unreported and unregulated (IUU) fishing occurs in all marine capture fisheries, either within national control or on the high seas. Typically, an IUU fishing vessel does not follow any management rules or bycatch reduction methods. They will fish on spawning fish populations, juvenile fish, in closed areas or on closed fisheries and follow no quota (Balton, 2004). Controlling IUU fishing is problematic as vessels can relocate and often reflag, rename or change ownership (Miller, 2004). The use of a flag of convenience is integral to IUU fishing. Marine species generally at risk are usually mobile, crossing national boundaries and the high seas. Conservation measures must then be voluntary and can be ignored by vessels flagged to nations not party to the conservation agreement. Once at sea, fishing vessels can choose not to observe protocols. IUU vessels simply ignore conservation measures. The activities of IUU fishing can make management of regulated fisheries difficult. If a quota is allocated and IUU fishing is also taking a catch, then the fishery is very likely being overfished. If the regulated fishery reduces quota to try and take into account the IUU fishing, the regulated fishery will suffer and the IUU fishing vessels could simply take advantage of the increase in available fish.

For example, in the CCAMLR area the regulated longlining fishery on toothfish (*Dissostichus* sp.) averaged around 12,000 tonnes per year between 1997 and 2003, while the IUU catch was around 7,500 tonnes (2009/10: 1,615 tonnes (CCAMLR, 2010)), giving a total catch 62% higher than the regulated quota. Over the same period, the seabird bycatch in the regulated fishery declined to about 1000 seabirds per annum, while the IUU bycatch was about an average of 50,000 seabirds (high: 70,000 (1998); low: 20,000 (2003)) (Miller, 2004). IUU fishing has been estimated to be a major fisheries pressure, contributing to overfishing and ecosystem decline (Coll et al., 2008). Globally, the catch of swordfish and tuna was a reported 680,000 tonnes (in 2000) with the IUU catch an estimated 85,000 tonnes, making the total catch 12.5% more than what one would presume to be the sustainable regulated catch (Lewison et al., 2004). In PNG, IUU fishing is reported to be 14% of legally reported catch value (Williams, 2007). IUU fishing off West Africa is an estimated 40% higher than reported catches (Agnew et al., 2009).

Ghost nets

'Ghost net' is a catchall phrase for abandoned, lost or otherwise discarded fishing gear (ALDFG). The principle is simple, particularly when fishing gear is generally made from durable and non-biodegradable plastics, it is the continued fishing and killing of marine species by ALDFG trawl nets, gill nets, pots and traps, and other gear types (see Fig. A4). In Europe there are approximately 7958 nets lost annually resulting in an estimated 209 km of ghost nets every year. Ghost gillnets continue to fish and take about 15% of the normal rates of catch. However, owing to tangling, bundling, and fouling, the average fishing time for ghost nets in the EU is 6-12 months, although ghost nets in the halibut fishery off Greenland can fish for 2-3 years (Macfadyen and Brown, 2007). In Australia, the Carpentaria Ghost Net Program collects beached nets from accessible beaches at an average 2.5 km of net per month (Macfadyen et al., 2009).

Fish traps and pots can also fish for some time after being lost. In Queensland, Australia, the blue swimmer crab (*Portunus pelagicus*) is the target of a commercial pot fishery. Annually about 3000 pots are lost. Pots ghost fish by attracting marine animals into the pot, often trapping them. These die and attract more animals and the cycle continues until the pot degrades or settles into the sediment. In Queensland, traditional pots have been largely replaced over the last decade with trawl-net mesh pots which are durable and non-biodegradable. The fishers estimate that a lost mesh pot will ghost fish for four to ten years. After accounting for escapement, 10,395 to 41,646 crabs die in these lost pots each year. When the regional SE wind shifts are taken into account, as they greatly increase crab catches, the rate rises to a mortality of 670,866 crabs per year (Campbell and Sumpton, 2009).

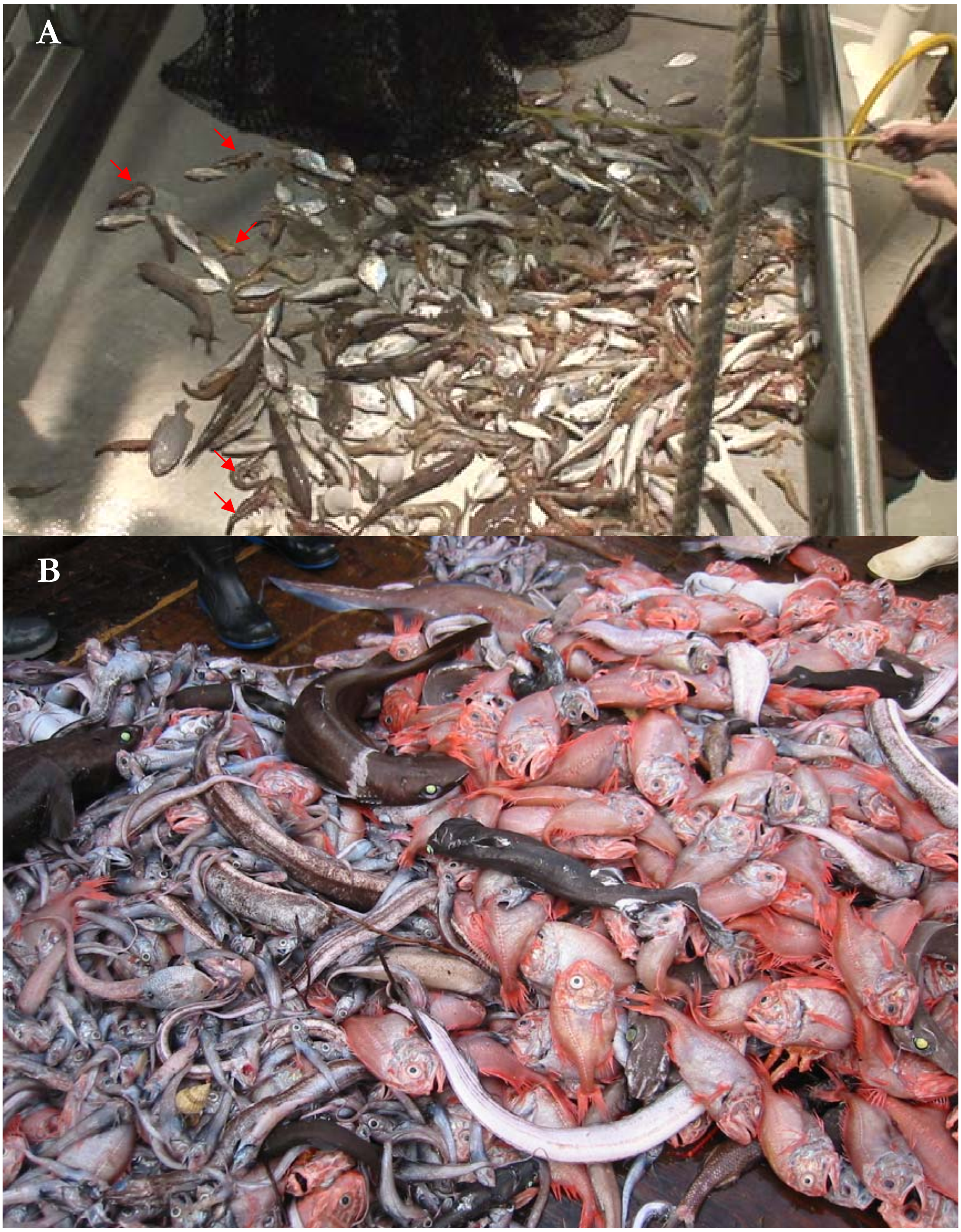

Fig. A3 **A** Bycatch from the Northern Prawn Fishery (NPF), Australia's most lucrative prawn fishery. Bycatch rates have been estimated at up to five kilograms of bycatch species for every kilogram of prawns caught (some arrowed), 97% of NPF bycatch is dumped at sea.
Location: off Yorke Island, Gulf of Carpentaria, 2006.
B Bycatch taken in a research trawl on orange roughy (reddish fish on the right). Bycatch mortality in this fishery is 100%. Location: onboard the *FTV Bluefin* off the East coast of Tasmania, 2006. (Both images: Stephen McGowan, Australian Maritime College, 2006/Marine Photobank)

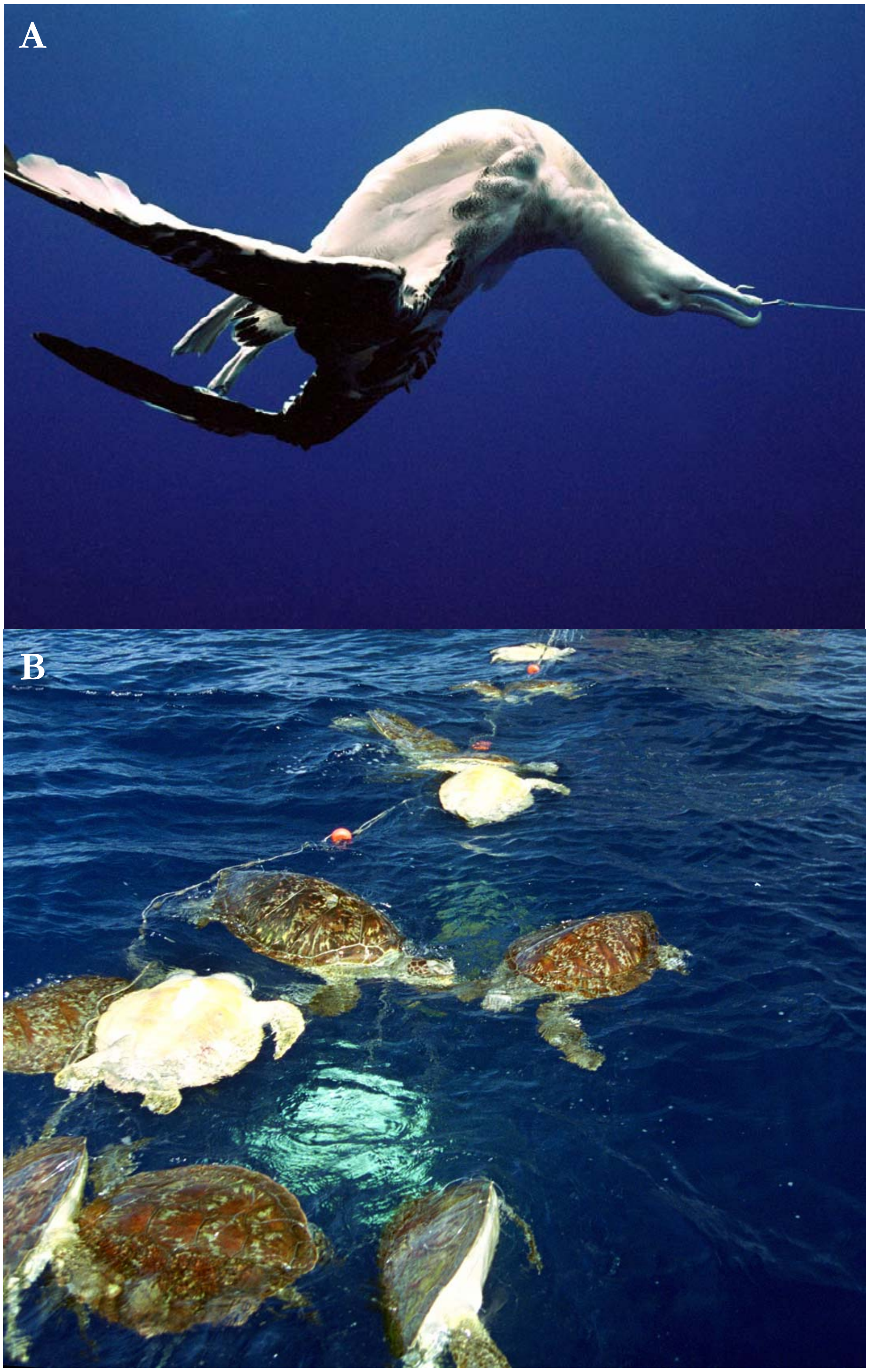

Fig. A4 **A** An albatross caught and drowned on a pelagic longline hook. Of the 22 species of albatross, two are critically endangered, 19 threatened and one near threatened as the direct result of industrial fishing by longlining (especially in the subAntarctic), and trawling (especially off the coast of West Africa). Location: offshore Bahia, Brazil, 2005.
B A ghost net found at sea carrying 17 drowned sea turtles. Of the seven species of sea turtles, three are endangered and three threatened. Location: offshore Bahia, Brazil, 2005.
(Both images: Projeto Tamar Brazil/Marine Photobank)

In the Gulf of Oman, approximately 20% of fish traps are lost per year and retain their capacity to ghost fish with a 95% mortality rate. The mortality rate over a six month period was estimated at 78.36 kg per trap, mainly commercially valuable fish species and cuttlefish (*Sepia* sp.), with the catch declining steeply after (Al-Masoori et al., 2004).

A critical element of bycatch, IUU fisheries, and ghost nets is the effect on endangered species under what is called is 'deathbed conservation' (Parentau, 1998; Kunich, 2005; Trouwborst, 2008). The issue is that most endangered species acts and agreements (like CITES), are essentially reactive, in that human use of a biological resource is 'business as usual' until the target species or an ecologically related species is depleted to the point at which it is at risk of extinction. On land, defining and policing protected habitats and behaviours is easier than at sea.

Conservation policy can fail: Tuck (2011), showed that the subAntarctic fishery conservation action point of 0.5 birds per 1000 hooks may remain below that point because the population continues to decline, but as far as conservation objectives are concerned the species is surviving. Frazer (1992) questioned the intensive and expensive captive breeding programs for sea turtle, when the turtles are then released into the same environment that is sending the species extinct. In the face of continued global marine capture fishing, conservation of endangered species is problematic, or what I call 'IUU conservation': Ineffective, Unmanageable and Unenforceable.

Pollution

Pollution has a largely hidden but major effect. Sewage and agricultural and industrial runoff causes 'dead zones' where eutrophication has removed oxygen from the water. Chemicals in this global runoff enter the food chain and bioaccumulates to the detriment of marine life. Pollution enters the deep sea from the cargo ships that sink each year and from at-sea waste disposal, often illegal. Toxic persistent organic pollutants are a feature of this pollution. Plastic waste is flushed into the ocean from rivers, or dumped into the ocean from ships; it is the largest component of marine debris (Derraik, 2002). This plastic does not biodegrade but breaks down into smaller and smaller particles. These small particles sorb chemical pollutants from the water column or contain their own toxins and are eventually eaten to deliver their toxins to the animal, as well as having no nutrient value. Plastic waste collects on islands and traps and injures wildlife. An estimated 100,000 marine mammals die in the North Pacific each year from plastic entanglement and ingestion (Wallace, 1985)

In the ocean, gyres concentrate plastic waste into patches hundreds of kilometres wide. Moore et al. (2001) sampled the North Pacific central gyre and found 334,271 pieces/km^2 at the neuston size, which weighed in at 5.177 kg/km^2. This was six times the mass of plankton but the plankton was five times more abundant. The effect on filter feeding organisms is poorly understood but the implications are that they would be undernourished, poisoned, and lose fitness. Larger pieces are known to kill tens of thousands of seabirds by clogging their digestive tracts and those of their young, which are fed items such as cigarette lighters that have been mistaken for fish (Ryan, 1987). Marine turtles are similarly affected.

Habitat Loss

Habitat loss is occurring across the ocean, from the coast to the abyss. Along with species depletion by fishing, bycatch and IUU fishing; habitat loss is having a profound effect on the ecosystems of the ocean. Anthropogenic habitat disturbance and loss has been happening for millennia, estuaries being one of the most affected coastal habitats owing to the human habit of establishing cities and towns on estuaries and reworking them. Wetlands are drained and mangroves cleared worldwide. In the Adriatic, 75% of species that provide habitat and filtering roles have been removed (Lotze et al., 2010) affecting the entire ecosystem function of that sea. Oceanic seafloor communities and habitats have been greatly altered in the last century, owing to the expansion of trawling worldwide. In the North Sea, where bottom trawling continues throughout the year, large scale changes have been seen. Tillin et al. (2006) found that seafloor filter feeding, attached and larger animals were more abundant in lightly trawled areas but in heavily trawled areas, the ecosystem shifted to mobile animals, scavenger crabs and infauna. Epibenthic flora and fauna do not survive repeated trawling with effects throughout demersal, pelagic and coastal ecosystems.

These effects were seen at the large scale fishery level by Thrush et al. (1998) in Hauraki Gulf, New Zealand; they found that with decreased fishing pressure there was an increase in epifauna, echinoderms and long-lived surface animals as well as an increase in species diversity and abundance. Trawl fishing changes to the seafloor lead to the functional extinction of key species and communities and pose a threat to the structural and functional biodiversity on the seafloor and above it, changing the ocean as we know it, leading to the shifting baselines syndrome (Thrush and Dayton, 2002; Jackson and Jacquet, 2011).

Deep sea trawl fisheries are rapidly expanding as shelf fisheries decline and these deep sea ecosystems are even more vulnerable to bottom trawling and serial depletion, as these animals typically have slow physiology, long life, and low reproduction rates (Morato et al., 2006; Davies et al., 2007; Norse et al., 2012). Physiological stress and barotrauma ensures that no organism taken from these depths survive, either as catch or bycatch; while bottom trawls destroy deep sea benthic communities, e.g. coldwater corals, leading to an exponential loss of biodiversity (Danovaro et al., 2008)

People and the Sea

People have always fished the sea and overfishing and species extinction has accompanied this; for example, Steller's sea cow disappeared from its entire range by the early Holocene, surviving on a single island which had not been found by the indigenous peoples. It finally went extinct within three decades after that island was discovered by Europeans in 1741 (Jackson et al., 2001; Roberts, 2007). From the perspective of the individual today, the ocean is vast and the marine life abundant (but vastly less abundant than it was a century ago). The right of people to exploit marine resources has a long history:

> And truly by natural right, these be common to all; the air, running water, and the sea, and hence the shores of the sea. … And by the law of nations the use of the shore is also public, and in the same manner as the sea itself… The right of fishing in the sea from the shore belongs to all men…
> *Roman Civil Law, Institutes of Justinian, Liber Two, Tract One, Section One.*
> (cited in Weinstein et al., 2007)

The huge fish schools (cod, herring, pilchard, pollock, sprat, etc.), vast bales of sea turtle, whale pods that crowded the sea to the horizon, the seabird colonies that blackened the sky, oyster beds that stretched out of sight, elvers (young eels) that filled coastal bays and inlets until there seemed to be more elvers than water, cod that could be hauled out just by dropping a basket into the sea, seemed to make the abundance of the ocean inexhaustible. Indeed, the famous biologist, T.H. Huxley, declared during the 1883 Royal Commission into the effects of trawling that, 'all the great sea fisheries are inexhaustible' (King, 1995), which was also the title of a popular 1955 book, *The Inexhaustible Sea* (Roberts, 2007). This view is virtually ingrained in the society's cultural psyche even today; note the numerous fishing programs on television and the popularity of recreational fishing.

The freedom of the seas for fishing, trade and travel, was further infixed by Grotius' legal idea of *mare liberum* in 1608, codified in the Treaty of Westphalia (1648). The legal concept of 'Freedom of the Seas' continues today with the 'open access' nature of the high seas as 'The Great Void' (Steinberg, 2001). Going to sea is freedom; the sailor can go wherever the wind sets and the riches of the sea are abundant and free to take. This is the generalized romantic view. In reality, there are many international and intergovernmental agreements and rules about how the sea is used; from marine waste disposal to fishing. Yet, globally, fisheries are collapsing and even the European Union has admitted that the Common Fisheries Policy is a failure: Unable to protect fish stocks, provide a sustainable food source, or profitable fisheries with 88% of EU fisheries overfished and 30% of EU fisheries collapsing (Williams, 2002; Williams, 2008: Brown, 2011).

Overfishing

Seafood is the most highly traded food internationally (Smith et al., 2010) and overexploitation, as overfishing, is common to the world's oceans (Coll, et al., 2008; Williams, 2008: Williams, 2010) despite sophisticated science (Young, 2003). For example, in 1889 in the UK the catch was three times larger than today; in 1937, at the fisheries peak, the landings were fourteen times greater than today (Williams, 2010).

The effects of current and historical overfishing (Jackson et al., 2001) are now beginning to be understood. Hutchings (2000) has found that despite conventional wisdom, populations of overfished species do not necessarily recover quickly, with recovery being on the scale of years. As the apex predator in the ocean (Verity et al., 2002), humans are changing the phenotypes of marine species at an extremely rapid rate. This 'harvest selection' is reducing the size of fish and affecting life history traits. One example being the reduction in size of the world's largest fish, the whale shark (*Rhincodon typus*), over the last decade this shark has become 40% smaller and less abundant (Bradshaw et al., 2008). This can affect population numbers and dynamics, reduce fecundity, and affect ecological interactions with other organisms in the system as well as modifying the structure and function of the affected ecosystem as a whole (Darimont et al., 2009). Overfishing also distorts ocean ecosystems by 'stripping out' the biomass, and hence energy, of a trophic level and denying this resource to higher trophic levels (Coll et al., 2008).

Fisheries also take the apex consumers resulting in trophic downgrading and the effects of this alter biodiversity (Lynam et al., 2006), ecosystem dynamics and ripple out into carbon sequestration, disease dynamics, biogeochemical cycles (e.g. iron cycling by whales in the Southern Ocean), invasive species and the persistence and resilience of ecosystems and species (Estes et al., 2011). Food webs in the open ocean are being altered, affecting the ocean ecosystem (Hinke et al., 2004). At the human level, fish products contribute a global average of at least 15% of human protein consumption (Smith et al., 2010) and that figure is expected to rise with the growing global population. With over 20 million fishing boats at sea (Williams, 2010), overfishing is not only the depletion of marine species but the alteration of whole ocean ecosystems and productivity which, along with the depauperation of the ocean, will have profound effects on human nutrition in the next few decades.

Fishers are phlegmatic. Jack mackerel populations have plummeted in the Southern Pacific, going from an estimated 30 million tonnes in 1990 to less than three million tonnes today. The world's largest trawlers are heading south for jack mackerel, including the 144 m *Annelies Ilena* (formerly the *Atlantic Dawn*). "It's going fast,' Pineda said. 'We've got to fish harder before it's all gone.' Asked what he would leave to his son, he shrugged, 'He'll have to find something else." (Rosenblum and Cabra, 2012).

In this introduction I have briefly outlined several of the main stressors on the marine environment that exacerbate, or magnify, the ecological effects of overfishing. The ocean environment also faces anthropogenic forcing in ocean acidification, ocean heating, and oceanic oxygen depletion. These broad scale changes may well alter oceanic plankton populations at the base of many ecosystems as well as the survivability of larvae and the capacity for shell-building animals to form calcareous shells - from the littoral to the deep sea (Brierley and Kingsford, 2009). In the next chapters I explore and define the major causal element of overfishing: the science-policy gap. I conclude by explaining that unless the gap is directly and clearly addressed, no management practise, either proposed or currently used, will succeed in reducing or removing overfishing and mitigating the overall impact of fisheries on marine ecosystems.

1 The progress of the science-policy gap in the primary literature: Pre-1990

1.1 Introduction

The 'science-policy gap' is a new term for an old issue and tracing the science-policy gap in the primary literature is a difficult process. The phrase first appeared in press during the mid-1990s (Bernstein, 1995; DellaSala et al., 1995; King, 1997) although Snow (1959) uses a prototypic term in reference to science and arts culture: 'Closing the gap between our cultures is a necessity in the most abstract intellectual sense, as well as in the most practical'. The science-policy gap is a term used to describe the set of known difficulties in the dialogue and relationship between science and policy. These problems are broadly: cultural differences between science and policy; dialogue and communication; the role of science in policy; the use and effect of science in policy; interference in the science-policy relationship; lack of scientific knowledge in policymakers; differing motives in science and policy; uncertainty (Axell, 2001; Court and Young, 2003; Anon, 2006; Saner, 2007).

The science-policy gap has several homologues in the primary literature: The science/policy interface; the knowing-doing gap; the information-action gap; the research-implementation gap and, going back in time, the 'problem of implementation' (Churchman and Schainblatt, 1965). To track the elements of the present conception of the science-policy gap, I searched online databases such as JSTOR, CAB, ISI, and several metasearch engines as well as searching journals themselves (e.g. *Nature*, *Science*, and *Marine Policy*). In these searches I used the homologue terms and also terms describing the science-policy gap (e.g. science AND dialogue, science AND policy, science AND interface).

There were many false positives, for example, many returns were related to government science policy particularly from the Sixties and Vannevar Bush's 1945 report, *Science – The Endless Frontier*. Some of the returns mentioned the science-policy gap or its factors only tangentially and so were discounted. I have arranged them into a period order in the following sections of this chapter, but for later years (Chapter Two) I found it effective to arrange the papers into themes that reflect the strands of discussion at the time. Below is a table showing some of the journals sourced and the number of papers appearing in each, this gives both an idea of the scope of the research fields that have touched upon the science-policy gap and, by the number of papers in a journal, how important the science-policy gap is to the journal's readers.

In effect, I am 'hindcasting' the factors of the science-policy gap to see how they progressed over time, but when they did appear what we call the science-policy gap was not known as such. When Snow (1959) mentioned 'closing the gap', he was referring to the divergence between the fields of science and literature (or more broadly, the arts). When present workers mention the gap between science and policymaking they are usually referring to factors such as differing time pressures, differences in scientific research interests, policy relevant research needs, and so on.

This chapter unravels the origins and development of the science-policy gap from the earliest appearances to its wider adoption, beginning in the 1990s. What we see in the past is a continuing discussion about factors affecting the relationship between science and policy which coalesce into a delineated set of factors that are now called the science-policy gap. What we see in the past is a continuing discussion about factors affecting the relationship between science and policy which coalesce into a delineated set of factors that are now called the science-policy gap

This convergence began in the 1950s, when the discussion was about science and politics on a generally national level as two societal forces. The relationship between science and the policy process became more focused in the 1960s. Perhaps the earliest use of the term 'gap' is by Jordan (1961):

> It was mentioned earlier that the gap between laboratory results and their application in real life is not restricted to the social sciences but is also true for the physical sciences.

The word ‘gap’ in terms of the relations between science and policy first appears in Alderson’s comment in Churchman et al. (1965):

> As a parting shot I will remind the authors of my insistence on a distinction between a conclusion and a decision. While this gap may be only inches wide, it is, in my opinion, a thousand feet deep.

By the 1970s, science and policy was a focus with Bernard (1974) writing a key paper, *Scientists and Policy Makers: An Ethnography of Communication*, wherein he interviewed 25 marine scientists at Scripps Institution of Oceanography along with policymakers interviewed in Washington and at the Law of the Sea Conference in Rhode Island. My thesis is perhaps the first direct investigation of the science-policy gap since then.

Table 1.1 Some journals searched for this thesis and the number of papers involving the science-policy gap therein.

Journal title	Number of papers
Marine Policy	24
Science	18
Conservation Biology	12
Bioscience	12
Environmental Science and Policy	8
Trends in Ecology and Evolution	5
Nature	4
Management Science	4
International Challenges	4
Environment	4
Ambio	4
The American Political Science Review	3
Wildlife Society Bulletin	3
The Scientific Monthly	3
Policy Sciences	3
ICES Journal of Marine Science	3
Biodiversity and Conservation	3
Philosophical Transactions of the Royal Society B	2
Transactions of the Institute of British Geographers	2
Marine and Freshwater Research	2
Proceedings of the Academy of Political Society	2
International Studies Quarterly	2
International Environmental Agreements: Politics, Law and Economics	2
Forest Policy and Economics	2
Fisheries Research	2
Environmental Management	2
Ecology and Society	2
Ecological Society of America	2
Ecological Economics	2
Canadian Journal of Fisheries and Aquatic Sciences	2
Biotropica	2
Australian Journal of Public Administration	2
Annual Review of Ecology and Systematics	2
American Journal of Public Health	1
Weed Technology	1
The Western Political Quarterly	1
Sustainability Science	1

Statistical Science	1
South African Journal of Science	1
Scientometrics	1
Science and Public Policy	1
Reviews in Fish Biology and Fisheries	1
SciDev.net	1
Research Technology Management	1
Proceedings of the American Philosophical Society	1
Political Science and Politics	1
Policy Studies Journal	1
PloS Biology	1
Ocean Development and International Law	1
Minerva	1
Local Environment	1
Journal of Forestry	1
Journal of Environmental Management	1
Journal of Applied Ecology	1
Journal for the General Philosophy of Science	1
Issues in Science and Technology	1
Issues and Trends	1
International Journal	1
Integrated Assessment Journal	1
Human Organisation	1
Human and Ecological Risk Assessment	1
Foreign Affairs	1
Environmental Policy and Governance	1
Environment International	1
Educational Researcher	1
Ecosystem Health	1
Cultural Studies <—> Critical Methodologies	1
CSPO.org	1
Coastal Management	1
Climatic Change	1
British Medical Journal	1
Background	1
Annual Review of Anthropology	1
American Zoologist	1
American Behavioural Scientists	1
Acta Sociologica	1
	n = 224

1.2 Pre-1990

It can be argued that the first evidence of a gap between science and policy can be found in 1663 with the formation of the Royal Society when Robert Hooke, one of the founders, wrote in the rules of the Royal Society (cited in Todd, 1976):

> The business and design of the Royal Society is - To improve the knowledge of naturall things, and all useful Arts, Manufactures, Mechanick practises, Engynes and Inventions by Experiments - (not meddling with Divinity, Metaphysics, Moralls, Politicks, Grammar, Rhetorick, or Logick).

As Todd notes, Hooke was working to ensure that the Royal Society and its activities remained separate, neutral, and insulated from the political and social foment of his time. One should recall that just 30 years prior to the foundation of the Royal Society, Gallileo had been put on trial for his life for the 'vehement suspicion of heresy' by supporting heliocentrism. This delineation between science and polity has set the course for the role of English science and, by extension, Europe, Australia and Canada (Price, 1959).

In the United States, the pursuit of science followed a slightly different path. When the American Philosophical Society was founded in 1743 Benjamin Franklin, one of the founders, wrote into the rules that the purpose of the Society was (cited in Rothwell, 1959):

> ... all philosophical Experiments that let Light into the Nature of Things, tend to increase the Power of Man over Matter, and multiply the Conveniences and Pleasures of Life.

This different intent meant that while English science was largely following basic science to 'improve the knowledge of naturall things', American science became more focused on applied science and technology to 'multiply the Conveniences and Pleasures of Life' (Howe, 1890; Price, 1959). While the situation has changed dramatically over the years (the Royal Society now has a policy centre and will offer advice on issues of importance without invitation (Rees, 2010)), these differences have had an influence on how science related to politics between the countries.

Science in America has been more of a tool of Government (e.g. Vannevar Bush's, *Science – The Endless Frontier*, the Moon landing, and 'Big Science'); although Price (1959) argued that science (particularly physics) was held in high esteem by the civil administration during the time of the Cold War and arms race. However, the use of science controlled by government remained, an attitude shown by President John F. Kennedy (cited in Lubchenko, 1998):

> Scientists alone can establish the objectives of their research, but society, in extending support to science, must take account of its own needs.

While earlier Eastman (1897) wrote:

> It should never be forgotten that our Government as represented by the Executive, Legislative and Judicial powers is simply the agent of the people, not *some* of the people, but *all* of the people, and that they are entitled to the best service to be found within the borders of our broad domain. To that end it follows that personal claims, clamor of cliques … should have little or no weight in the proper organisation and control of the scientific work of the Government … and where practical and theoretical results and investigations, in their proper mutual relations, and controlled by wise economy, should be the single aim of Government.

The Nineteenth century was an industrial and scientific revolution. Discoveries appeared every year; the steam engine, dynamite, anaesthesia, synthetic dye, the spectroscope, Bessemer steel, the phonograph, the electric light. The Nineteenth century saw among others; the birth of chemistry, Darwin's theory of evolution, the cell theory and microbiology. One can say there was a triumphal air in society, science had provided society with new wonders, safety, comforts and material wealth but at the close of the nineteenth century we can see the first comments about the role of science and politics. Science had become a major force in society and Eastman (1897) was concerned about the moral nature and motivation of scientists. Of scientists he wrote:

> In general he differs from his fellows only in the possession of some peculiar aptitude or talent for study or investigation in some department of science. He may be a good chemist, and shirk every duty of a good citizen; a learned mathematician, with manners and tastes that bear no trace of gentle breeding or moral training; a gifted biologist, but with a selfish greed that puts him out of touch with the best citizens, the wisest government or the true unselfish seeker after truth in any sphere of human endeavour; in short, the manifestation of ability in scientific pursuits, as in other walks in life, do not necessarily imply the possession of good morals or the other qualities that make a good citizen. … Many times in every year the executive and administrative officers of our Government find it necessary to ask for the opinion and council of scientific men. Frequently these same men feel moved to offer their views and advice to the Government, and on all such occasions they have ample opportunity to exhibit whatever unselfish, self-respecting and patriotic characteristics they may possess. If, however, the representatives of the Government find that a body of scientific men have urged the appointment, to a position of trust and responsibility, of one whom they must have known, if they knew the man, was morally and mentally unfit for the place; or if they put in train a scheme for their personal aggrandizement or professional profit, then they have plainly cheapened their own influence and damaged the reputation of all scientific men in the country in the opinion of the Government officials; and they have no right to complain of lack of appreciation by men whom they have once deceived.

Here one can see a nascent expression of a factor in the science-policy gap; distrust in the agenda of science, as seen in contemporary comments of 'rent seeking' by climate scientists. There is also a concern that scientists may be advocating for their own purposes; then for personal profit and status, now for policy results they may favour. The issue of communication in science and policy was directly addressed in 1901 by T.A. Rickard. In a paper that argued for greater simplicity and clarity in scientific writing and commenting that much scientific writing was of poor quality in language, had clumsy terminology, and having excessive use of Greek-English words, he included this plea:

> In all seriousness, however, is it too much to ask that such technical terms as are considered essential shall not be used carelessly, and that in publications intended for an untechnical public, as are most government reports, an effort be made to avoid them and, where unavoidable, those which are least likely to be understood shall be translated in footnotes.

Miller (1903) presented an early example of Snow's (1959) 'Two Cultures' but with the optimistic hope for reconciliation:

> Francis A. Walker, late president of the Massachusetts Institute of Technology, in his remarks at the dedication of the new science and engineering buildings at McGill University, Montreal, said: "The notion that scientific work was something essentially less fine and high and noble than the pursuit of rhetoric and philosophy, Latin and Greek, was deeply seated in the minds of the leading educators of America a generation ago. We can hardly hope to see that inveterate prepossession altogether disappear from the minds of men who have entertained it. Probably they will have to be buried with more or less of their prejudices still wrapped about them, but from the new generation scientific and technical studies will encounter no such obstruction, will suffer no such disparagement." … Technical, scientific and liberal branches in the past have been separated. Now they work side by side, each rendering the other valuable assistance. Science has revolutionized the old and effete systems, and opened wide the door of knowledge and of life.

Since the Nineteenth century and even during it science has had periods of distrust by general society. No more so after industrial warfare emerged, then the atomic age, the effects of pollution and, more recently, the development of genetically modified organisms and the populist rejection of climate science. The use of the results of science in World War One brought recognition of the dangers of science, but the benefits of science were still manifest and praised:

> The minds of all thoughtful people are dwelling daily upon another great application of science – the European and worldwide war. … The prostitution of science to the killing and crippling of men is indeed an ugly fact, but its results are neglible in comparison to the daily ministrations of science to the people's needs. … It is, if you please, in full harmony with the spirit of Christ. Support is given to research by governments and by generous men and women in order that the truth may be found and made available in the service of mankind (Campbell, 1915).

> A recent writer in *The Atlantic Monthly* holds science largely responsible for the extirpation of culture, and claims that it has challenged the supereminence of religion, has turned philosophy out of doors, has thrown contempt on all learning not dependent on it, and has purchased support by the bribe of material comforts. Some have attributed the great war to the suppression of spiritual values by the influence of science, and its horrors to malignant investigators who spend their lives in devising agencies of death and destruction.
> … When this war is over it will be in a large measure the mission of science to rebuild a shattered civilization. It will restore the industries of nations; it will house the homeless, feed the hungry and cure the sick. But it will be even more potent in healing the deep-seated ills of society which are the consequences of past social misconduct, whether innocent or malicious. … It will be the task of men of scientific training or of scientific spirit to heal the wounds which have been wrought by the duplicities of statesmanship, by the selfishness of privileged classes, and by false philosophies and religions, and to remove malignant economic growths by radical operations.

> It is, I believe, the highest mission of science to contribute its part to the training of such men.
> The objective by-products of science, such as the telephone and the automobile, seem to me to be of relatively little importance; but its subjective influence on man's intellect and conduct is of the highest consequence. In universal scientific training in this larger sense lies the hope of democracy (Lewis, 1918).

A major factor of the science-policy gap is political interference. An early example of this is found in Bogue (1993), who examined the 1892-6 Joint Commission to investigate the Great Lakes fisheries. These fisheries were under pressure and there were vocal and sustained calls for action to end the destructive fishing techniques and to create closed seasons and restocking programs. Bogue found:

> Simultaneously, on December 31, 1896, the commissioners sent copies of it [their report] to the United States secretary of state and to the minister of marine and fisheries of the Dominion. Their document bore the same date as the prophetic warning of the Ontario commissioners of game and fish, and in the more restrained language of fishery experts, it carried the same message. Along with a status review of commercial fishing in all contiguous waters, the report included a draft of regulations designed to conserve the fish. The commissioners believed it imperative to adopt those regulations and to create a permanent joint commission to monitor and investigate changing conditions in the fisheries. That body should have the power to modify the rules originally sanctioned as "circumstances may call for from time to time."

> Neither the United States nor the Canadian governments followed those recommendations. The report remained on hold in the Dominion Department of Marine and Fisheries. In the United States, outgoing president Grover Cleveland referred it to the Committee on Merchant Marine and Fisheries in the House of Representatives, and there it died. In both nations, shifts in political power between 1892 and the completion of the commission's work in December 1896 led politicians to shelve its findings. Neither William McKinley's incoming administration nor Sir Wilfrid Laurier's chose to champion regulated conservation of natural resources.

Another element of political interference is partisan science and the fear of science of being drawn into political debate where the values or agenda of science might be questioned or smeared. This led, in 1920, to the American Association for the Advancement of Science to try and prevent politically contentious science being put before the Association (Fig. 1.1).

SCIENCE AND POLITICS

At the St. Louis meeting of the American Association for the Advancement of Science, the council passed the following resolution:

> That sectional officers avoid placing on their programs papers relating to acute political questions on which public opinion is divided.

I know nothing of the circumstances leading to this resolution. If papers offered to the sections were inspired by partisan politics rather than by science, they would deserve condemnation and exclusion. But the resolution does not refer to such papers; it implies that scientific men should not discuss matters relating to acute political questions on which public opinion is divided. To one who believes that in the present chaos of conflicting opinions and purposes the finger of science should point the way to safety, this seems almost incredibly stupid. I am of course aware that a scientific man who tries to throw the light of truth on the field of political discussion is not unlikely to be abused for his pains. He may find honest people doubting his integrity or his intelligence. He himself is only too well aware of his liability to error. But in the face of all this, he must and should persevere, knowing well that his feet are set upon the path of progress.

T. D. A. Cockerell

University of Colorado,
January 14, 1920

Fig. 1.1 A 1920s letter in *Science* showing concern about political interference in scientific discussion.

This letter seems almost modern in tone. There is the rejection of partisan political science papers and the implicit adherence to neutrality and objectivity. The belief that science should be heard in matters of concern despite the possibility of attack and that science should be true to itself. The question of scientific integrity on the part of the scientists is also raised. For modern examples of the debate, see Randerson (2004) and Sharman and Holmes (2010).

Little further appears of interest until after World War Two, when concern about the destructive forces unleashed by science reappear and in an address to the American Political Science Association, Charles E. Merriam (1946) said:

> At the threshold of the atomic era, we encounter new and very difficult problems in the organization on all levels of common human rights and the consent of the governed – the basis of protection and development of human personalities. Far greater concentrations of power than ever before known are on the way, in fact at the door. The time within which basic decisions must be made is short. …As never before, elements dealing with atomic energies will confront each other as follows: (1) military power and controls; (2) scientific power and controls; (3) industrial powers and controls; (4) the powers and controls of civil government. Armies, scientists, big business, the common man – all these titanic powers must be united and interwoven for purposes of security, and beyond that for peaceful exploitation of their possibilities. Centralization of power and authority must inevitably exist for some time in the construction and operation of huge and costly organizations of power.

Here Merriam places science as a power, a 'titanic power' no less, but one that must be under the control of a centralized power and authority. Like the writers just after the World War One, Merriam expresses hope for a new future, one of peace and science. Merriam sees politics and science united and proposes an American Committee on Atomic Energy:

> The politics of the sword cannot solve the new problems; nor the backroom politics of the spoils system in its many forms; nor the politics of arrogance dressed in a little brief authority. The new day is a challenge to the politics of intelligence; to reason and science; to generative and regenerative abilities; to faith in the future; to vision; to indomitable resolution; to unconquerable persistence.
>
> It is at this point that physics and politics meet, and meeting need never part, marching along together toward their common goal. I know we need the physicists and I am convinced that they need us, and will welcome a hand. This is one world, and one universe as well. If all this seems somewhat mystical or transcendental, a look at the custody and development of the atomic bomb may bring us back to earth again. For the bomb is only a symbol of unparalleled discovery of the resources of nature and eventually of man himself.
> …
> We need:
> 1. More intimate cooperation with the atomic scientists, who are looking for more light in political relations. Our needs are mutual, and there are great possibilities in joint action. Many of the atomic scientists have "got religion," so to speak – a sense of social responsibility for what they do; and if they get politics likewise, the world is on its way; or if they meet half-way the technicians in government, the result may prove not only exciting, but enlightening. I suggest the organization of an American Committee on Atomic Energy. Such a committee might come together for the purpose of considering the broad underlying problems raised by the new developments in atomic energy and its practical applications to human affairs, and for taking such action as seems appropriate from time to time.

While in America 'Big Science' began with military and government control and committee, across the Atlantic, British science and politics formed a common meeting place, with Linstead (1948) making this observation: 'Scientists do not make the best politicians, nor do politicians make the best scientists.'

> Yet science and politics interact one on the other, and there is real need for a common meeting place. In Great Britain, the Parliamentary and Scientific Committee is the means we have found for bringing the two groups together so that the scientist can influence the development of political questions, the politician can advise the scientist on the practical aspects of some of his problems, and the two together, politician and scientist can join in representations to the Government. The Committee is a nonparty body formed with the object of providing a permanent liaison between scientific bodies and Parliament and serving generally as a center for the consideration and discussion of scientific information bearing on current business in Parliament.
>
> The Committee has shown, too, that it can be a valuable forum for the discussion of major development projects that are still in embryo and need publicizing. The Channel Tunnel between England and France is one of these. Another is the Thames Barrage, to be built in order to hold up the in-sweep of the tide below London and thus keep the river through most of London fresh and unpolluted.
>
> Ministers and others attend and address the Committee and senior civil servants obtain special permission to discuss the work of their departments with it – a concession not readily granted by any Government which in the nature of things feels itself on the defensive in its dealings with Parliament. A word about the Committee's attitude toward lobbying by industrial or scientific interests will not be out of place. Members of Parliament and Ministers of the Crown are, of course, subjected regularly to the pressure of interested bodies over the whole range of governmental activity. Because of the special authority which the Parliamentary and Scientific Committee has established for itself, it would be a most effective machine for this purpose, and from time to time it has proved to be so.
> But the price of its authority is the rigorous standards it has set for itself. No industry or group of professional men which may, through one body or another, chance to be represented on the Committee acquires thereby any right to call upon the Committee to sponsor any demands it may have to make upon

> the Government. … It is by such selective advocacy that the Committee has developed its authority in the eyes of the Government and its true value to those who support it. … Great Britain's future is dependent upon the extent to which she can retain and develop her capacity for industrial production and upon her power to foster and exploit scientific research. In these vital fields there is a clear interlocking of science and politics. The task of the Parliamentary and Scientific Committee over the next few years is therefore clear. It is to unite the forces of polities and of science to ensure that government policy is shaped and carried through with these vital objectives constantly in view.

In 1950, Conant was the first to propose a 'judicial process' to resolve conflict between countervailing expert opinion, an idea that has recurred since, writing:

> An agency of the government faced with the type of technical problem here in question might establish regular procedures for "hearings" of experts who would be encouraged to present alter native solutions. Decisions of such technical tribunals might be subject to review, but the records would clearly indicate just what would be involved in a reversal of the "lower court." As in the judiciary or administrative machinery of government, it would take time to recruit the necessary personnel to man this type of organization, for this is no part-time hit-or-miss job that is being suggested. Laymen who understand science and scientists and are familiar with engineering and engineers rather than technical experts might well prove the most suitable men for this task of refereeing technical disputes.
>
> Whether or not there be any merit in these suggestions for improving the assessment of scientific and technical problems related to the work of the Federal Government, the existence of a serious problem is abundantly clear. To repeat, this is but one illustration of an important change which has taken place within a generation. An historian 50 years from now writing of the mid twentieth century will certainly record that science and politics were by 1950 no longer to be regarded as two totally unrelated activities. He might well add that scientists and politicians were in this period to be found sometimes in amicable cooperation, sometimes in violent disagreement; only one thing seemed certain, the type of society in which each could go his own way with only a polite bow to the other had disappeared as irrevocably as the American buffalo from the plains.

The problem that he saw was:

> … even the casual reader must be disturbed by the obvious conflict of expert technical opinion; and even more disturbed that this conflict has remained unresolved at the highest level. Members of Congress and civilian officials of the Federal Government have become involved in intricate questions which in large part turn on judgments about scientific and engineering problems. There can be no doubt that politics and science, once quite separate activities, have become intermeshed and at times the grinding of the gears produces strange and disturbing noises.

Conant divided the science into 'pure', mainly carried on at universities, and 'applied' that was carried out by industry and government particularly for the reason of defense during an 'armament race' with the Soviets. Engineering also factored in as part of disputes over expert opinion. Conant was not so much concerned with tension between science and policy, but rather how divided expert opinion caused problems for political decisions and was looking for a better way to control science for the national good, which was echoed by past writers such as Eastman (1897). The problem of disputed opinions is also a modern one and is part of the science-policy gap (see Sarewitz, 1999). Having separated science into 'applied', which was far more the tool of government agency and what became called the 'military-industrial complex' and academic 'pure' science, Conant was a proponent of the National Science Foundation which was designed to bring more pure research into the realm of government control, arguing:

> The applied scientist reaches the dead end of a road and calls to his colleague in the university laboratory for new supplies of scientific knowledge. Whence it follows that the nation must speed up the advance of science itself. This means that large sums of money must be spent on another speculation, another type of

> gamble, adventures in pure science. The implementation of this conclusion through a National Science Foundation unfortunately still awaits Congressional action.

Reading into what Conant wrote one can see that, like his contemporaries and predecessors, some quoted above; he saw the future of society as one that has science at the core of national philosophy and decisions. Accordingly he opposed partisan science such that:

> The worst way to make decisions is to resolve conflicts in favor of those with the loudest voice or the closest approach to political leaders. Propaganda and counter-propaganda on behalf of a new departure in an industrial concern would never be tolerated by good management.

Agenda driven science is a concern of current workers as is the influence of environmental and industry lobbyists. The independence of science from partisan agendas was the subject of Kelsen (1951):

> It is a commonplace to assert that science should be independent of politics. By this one usually means that the search for truth, which is the essential function of science, should not be influenced by political interests, which are the interests concerned with the establishment and maintenance of a definite social order or a particular social institution.

The use of science by policymakers is a current issue but is separate from politicized science; which is science that works to achieve a specific outcome to fit a political belief of agenda. Kelsen recognized the selective use of science is inevitable:

> Although science must be separated from politics, politics need not be separated from science. It stands to reason that a statesman, in order to realize his ends, may use the results of science as a means. Science in general and political science in particular may furnish these means, and only science can furnish the appropriate means; but, as pointed out, it cannot determine the ultimate ends of politics. However, to admit that these ends are in the last analysis based on subjective value judgments seems to be too difficult for those who – for political reasons – look for an absolute justification of the political system which they try to establish or to maintain. If they are not willing to find such justification in religion, they try to get it from science.

The strength of science, hearkening back to Hooke in 1663, was to him:

> But the splendid development of modern natural science may be attributed largely to its emancipation from political powers, and especially from the power of the Church. The fact that in the past natural science *has* been able to achieve complete independence is due – it is true – to a powerful social interest in its victory, an interest in that advance of technique which only a free science can guarantee.

The independence of science from partisan, factional, politics is an important principle, one acknowledged by Pielke, Jr (2007) as *The Honest Broker*. The selective use of science by policy to make decisions is one part of the science-policy gap while partisan science - science made to reach a foregone conclusion in support of a political position - is another. Policymakers can use partisan science to reach a conclusion or use independent science selectively to reach the same conclusion.

What is often called the 'cultural difference' between science and policy was the focus of Mather (1953). The main thrust of his argument has recent echoes, he was concerned about the freedoms of scientists to speak, share, and do research across political divides. In a time of the Cold War, he was concerned about intellectual freedom and the political suspicion of scientists trying to exercise that freedom. This was, for him, a main issue in the 'suspicion and jealousy between scientists and politicians', and he called for a 'mutual understanding among and between both groups.' The lack of understanding (cultural differences) between science and policy is a major current concern. Mather's opening comments, while directed at the conflict between research agenda and political suspicion of scientists talking to 'the other side' during the Cold War, does cast light on a fundamental difference between the two:

> At first reading, there are those who might cynically inquire 'is there any common ground at all between to such antagonistic fields as science and politics?' Conflicts between scientists and politicians have been so widely publicized in recent months that there might seem to be adequate basis for such a question. Scientists have criticised politicians for their ignorance of the strategy and procedures that have proved so efficient for the progress of science. Politicians have berated scientists for their impractical idealism and have even denounced them as subversive, when they object to security regulations and procedures that seem to them inimical to the continuing development of scientific knowledge.

The two things mentioned here; political 'ignorance' of the scientific procedure (or method), and the 'impractical idealism' of scientists have analogues in the present. Firstly, the belief that if science provides advice, policy will make a decision based on that advice (known as the 'deficit model', see Lawton, 2007). Secondly, that science is in the position to give that advice at the drop of a hat, in the timeframe that the policymakers work to or want.

In the 1950s, a project to dam parts of the Colorado River, known as the Upper Colorado Project, was contentious and Sears (1955) wrote in *Science* that the American Association for the Advancement of Science (AAAS) had been 'bombarded' with arguments for or against the project, presumably with the intent of getting the AAAS's support for one position or the other. For Sears this showed a defect in science and its relationship with 'public issues':

> Costly and important as this whole issue may be, its greatest significance lies in illustrating a serious defect in our national structure as far as the relation of science to public issues is concerned. … Public issues should not be clouded and confused by failure to get at the basic scientific facts. The role of science in a technologic civilization such as ours should be perfectly clear: to cut to a minimum the areas of uncertainty and dispute. … Similar intolerable and costly conflicts are likely to be more, rather than less, frequent as life becomes more complex through population increase and the growing demands of technology.
>
> The remedy is simple. It must become part of our habit of thought and a recognized procedure to insist that, in matters of public policy where verifiable physical knowledge is involved, such aspects of major problems be referred to impersonal, disinterested, and competent boards of scientists. We have, in the National Academy of Sciences and the National Research Council, a proper and legal mechanism for such assignments. These two closely interrelated groups have at their command the entire scientific talent of the nation. For various reasons, however, they cannot inject themselves into controversial issues, unless the Government or the public demands that they do so.
>
> One group of scientists has not shared this inhibition. The Engineers Joint Council has investigated and reported (unfavorably) upon the Upper Colorado project. But the air would be greatly cleared and an important principle established if the services of bodies representing all phases of science were called upon to analyze this and similar issues. Failure to use science as a source of perspective in our present stage of culture degrades its function and may in time be disastrous.

The passage quoted above is interesting for several reasons. The final line reflects a concern that is current now; that science has lost, or is losing, its place in society. This concern was most recently voiced by the Australian Chief Scientist, Professor Ian Chubb, who told a Parliamentary inquiry in relation to the debate over climate change: 'The scientific community as a whole has a great deal of responsibility to ensure science is elevated to where it once used to be, and not to be subject to attacks by people with all sorts of agendas.' (Anon, 2011).

Sears is also among the first to mention uncertainty, separating it from disputed science. Uncertainty became a focus of interest in the 2000s. Sears also echoes the 1920 decision by the AAAS not to become involved in 'controversial issues' unless demanded, and he presages the increase in controversial issues as technology grows. His solution is essentially a learned adjudication board drawn from the National Academy of Sciences and the National Research Council.

At the close of the 1950s, C.P. Snow gave his now famous Rede Lecture, *The Two Cultures*. This was an expanded version of his *New Statesman* article of 1956, and in it he sketched out a great divide between 'literary intellectuals' and 'the scientists'. In one of the more quoted passages he says that, '… Between the two a gulf of mutual incomprehension – sometimes (particularly among the young) hostility and dislike, but most of all lack of understanding. They have a curiously distorted image of each other. Their attitudes are so different that, even on the level of emotion, they can't find much common ground.' (Snow, 1959, p. 4). This sounds overly harsh, but the science-policy gap does include a strong, and ongoing, element of concern over cultural differences (lack of understanding) that are part of the discussion in later years. Snow refined his ideas in his 1963 essay, *The Two Cultures: A Second Look* (cited in Kemp, 2009):

> Persons educated with the greatest intensity we know can no longer communicate with each other in the plane of their major intellectual concern. This is serious for our creative, intellectual and, above all, our normal life. It is leading us to interpret the past wrongly, to misjudge the present, and to deny our hopes of the future. It is making it difficult or impossible for us to take good action.

Here Snow, as Kemp points out, is concerned with narrow specialization, or perhaps, over-specialization. The solution for Kemp is an education that, 'inculcates a broad mutual understanding of the nature of various fields of research'. Worster (1996) takes a similar line and pushes this cultural divide back to the mid-Seventeenth century and René Descartes, who 'announced that the world is divided into two opposing forces, mind versus matter, the consequence of the announcement being that scientists took up the study of matter, leaving the mind to the humanists.' The concern about cultural differences has been a major issue in the science-policy gap discussion, but in my argument I prefer this quote from Snow (p. 10-11):

> But I believe the pole of total incomprehension of science radiates its influence on all the rest. That total incomprehension gives, much more pervasively than we realise, living in it, an unscientific flavour to the whole 'traditional' culture, and that unscientific flavour is often, much more than we admit, on the point of turning anti-scientific. The feelings of one pole become the anti-feelings of the other. If the scientists have the future in their bones, then the traditional culture responds by wishing the future did not exist. It is the traditional culture, to an extent remarkably little diminished by the emergence of the scientific one, which manages the western world.

In today's world, particularly in marine capture fisheries, the traditional culture of maximized catch is in direct tension with scientific research saying that catches often should be reduced. In the case of climate change, it is again traditional culture becoming 'anti-science' and this aspect of the cultural gap was also addressed by Sir Eric Ashby in his 1971 Bernal Lecture (see below).
The problem of anti-science and traditional culture is not only one for the science-policy gap but one for all society, now and into the future.

The late 1950s and the 1960s were a turning point in global society. Ecology as a science came of age during this time. Ecological thought has probably existed since the first tribal cultures, and what we would call ecological thought can be seen in the works of the early Greek philosophers, such as Thales of Miletus and Pythagoras (Egerton, 2001). Other examples can be found, for example, the Bishnoi in India during the Sixteenth century (Gadgil, 1985).The beginnings of ecology as a science can be traced back to 1749 when Linnaeus wrote *Œconomia Naturae* and later, in 1775, *The Œconomy of Nature*:

> In order to perpetuate the established course of nature in a continued series, the divine wisdom has thought fit, that all living creatures should be constantly employed in producing individuals ; that all natural things

> should contribute and lend a helping hand to preserve every species ; and lastly, that the death and destruction of one thing should always be subservient to the restitution of another (cited in Stauffer, 1960).

The earliest usage of 'ecology' found in the United States is in an 1858 letter written by Thoreau (Goodland, 1975), which suggests that the term was in use and had crossed the Atlantic. While Haeckel is most commonly cited as the person who coined the term 'ecology' in 1873 (e.g. the OED), this is incorrect.

While Haeckel didn't coin 'ecology' what is more important, and why he can be correctly considered the founder of ecology as a modern science, is that he published the first definition of ecology as a science: 'The study of the natural environment including the relations of organisms to one another and to their surroundings' (cited in Odum and Barrett, 1971). When Haeckel defined ecology as a science in the 1860s the industrial and scientific revolution, which had began almost a century prior, was in full bloom. It also took almost a century for ecology to come into its own.

At the same time the world became environmental. Environmental thought, like ecological thought, has probably always existed and modern environmentalism, like ecology, had its origins in the mid-Nineteenth century. In 1876, in the English Lake District, the Thirlmere Defense Association formed to protect Lake Thirlmere from industrialization (Ritvo, 2003). In the 1960s, a series of events pushed the environmental effects of the industrial age firmly into the public consciousness. In 1962 Rachel Carson published *Silent Spring*, pointing the finger for bird population declines at pesticides. The Apollo 17 photograph of the Earth in space (*The Blue Marble*) focused people's attention on 'Spaceship Earth' as self-contained and vulnerable, with no emergency exits.

During the mid-Sixties the founders of what would become Greenpeace first gathered to raise protests against nuclear tests on Amchitka Island, Alaska (Wyler, 2004). In 1967 the supertanker *Torrey Canyon* ran aground off Cornwall, UK, causing oiled beaches along 180 km of Cornish coast with the oil slick crossing the Channel to coat 90 km of French beaches in highly publicly visible areas. Near the close of the decade, acid rain deriving from UK air pollution was damaging Swedish lakes and this became an international issue by 1970. Garrett Hardin's influential paper, *The Tragedy of the Commons*, was published in 1968; while the science journal, *Biological Conservation*, was first published in the same year.

This brief overview of the origins of the widespread and complex social changes in the Sixties serves two purposes. Firstly, ecology is a science defined as: 'The scientific study of the interactions that determine the distribution and abundance of organisms' (Krebs, 1994).

Yet often, in the public mind, ecology became interchangeable with environmentalism. At the memorial service for Rachel Carson the US Secretary of the Interior, Walter J. Hickel, eulogized her as 'the mother of the age of ecology' (Anon, 1970).

I consider that this blurring of definition and function may contribute to the science-policy gap, particularly when the science advises that an activity be reduced or prohibited. Anecdotally, I was once told that at an International Commission for the Conservation of Atlantic Tunas (ICCAT) meeting, the conservation groups and the likeminded were called 'the friends of the fishes' by other delegates.

It is not hard to see that a marine ecologist advising a catch reduction could easily be viewed politically as part of that group even if that advice was independent of that group and a scientific conclusion. Especially so with the growth of the wise-use movement over the last thirty years.

Secondly, this period had an increase in policy relating to the environmental effects of human activities. Environmental management policy has a long history, with perhaps the earliest recorded fisheries instance being the 1376 petition to King Edward the Third demanding that a beam trawl technique be banned as it was destroying the fishing ground benthos (Barwick, 1972). In the 1960s and the 1970s, the introduction of new policies aimed at environmental damage limitation was rapid, such as the 1970 Canadian Arctic Waters Pollution Prevention Act and the 1970 United States National Environment Protection Act. All of these legislated policies involved scientific information as part of the process. As Krebs (1994, p. 8) writes:

> The science of ecology is not solely concerned with human impact on the environment, but with the interrelations of all plants and animals. As such, ecology has much to contribute to some of the broad questions about humans and their environment. Ecology should be to environmental science as physics is to engineering. Just as we humans are constrained by the laws of physics when we build airplanes and bridges, so we are also constrained by the principles of ecology when altering the environment.

If some actors in the science-policy relationship have a political predilection, or perception, to view the ecological sciences as being akin, or tantamount, to environmentalism this may well influence their reception or prioritization of scientific results in the policy process.

While the majority of primary literature of the pre-1960s discussed the relationship of science to politics, during the Sixties and after, while there was still discussion of science and politics, the focus of discussion began to shift to discussing the relationship of science to policy and how the two interact; this period is the beginning of the discussion about the science-policy gap. The first two papers in the Sixties that placed science in context with policy were Shilling (1962) *Scientists, Foreign Policy, and Politics* and Murphy (1962) *Science and World Order*.

The first paper to directly address the relationship between scientist and manager was Churchman and Schainblatt (1965). While not directly about science and policy *per se*, their interest carries much of the hallmarks of the science-policy gap. Their concern was what they called 'the problem of implementation':

> We have used the term "implementation" to refer to the manner in which the results of scientific effort may come to be used by the manager. The "problem of implementation" is the problem of determining what activities of the scientist and the manager are most appropriate to bring about an effective relationship between the two.

They derived a four part matrix of the relationship between the scientist and the manager (policymaker) that has a similarity to Pielke, Jr's, *The Honest Broker*, although written at a different time and for a different audience. They recognized:

1. The 'separate functionalist' who 'thinks of management and research as essentially separable functions.'
2. The 'communicator' who 'emphasizes the need for creating more understanding on the part of the manager, i.e., for creating better lines of communication.'
3. The 'persuader' who 'views the implementation problem in terms of the manager's personality.'
4. The 'mutual understander' who 'takes a synthetic position which embraces the positive aspects of the previous positions in the effort to bring about the successful union of managers and researchers.'

Churchman and Schainblatt's paper generated interest and in the same year *Management Science* published a selection of the comments, running to 40 pages for twelve selected responses (Churchman et al., 1965). Going through the comments we can see several issues that relate to the science-policy gap. First is that of value judgments, which appeared as a topic in the 1990s. Abrams wrote:

> We may consider the mutual understanding position from the point of view of a controller situated in another dimension surveying the problem from a detached position, but who may govern the course of action by manipulating the appropriate controls. Who is to assume that position? It is the one automatically assumed by those who set value judgements on progress.

> Can we really feel confident we have chosen the best course? Our confidence may further weaken if we contemplate that by bringing the scientist and manager closer in mutual appreciation we may encounter the sterility of harmony rather than the fertility of intellectual conflict. Progress along the mutual understanding path may pose dangers, but it may also serve so to enlarge our perspective as to introduce dimensions of discourse presently inconceivable.

While Alderson commented:

> It has been asserted that authorizing an investigation can be a thoroughly rational act for the manager under any of these four categories. It can be asserted just as positively that any of the four types can be carried out with complete scientific rigor and objectivity. What does differ, however, in these four categories is the way that the consultant should comport himself while the study is going on and what recommendations he should make for application when the study is over.
>
> If the authorizing executive is sincerely seeking a solution to a decision problem, the consultant should try to understand all of its psychological, social and career implications in order to make recommendations which are likely to have a favorable influence on executive behavior. If a consultant is engaged in a purely ritualistic exercise, it may be best not to know what is going on and to appear as diligent and sincere as possible in the pursuit of his studies. These may turn out to have value in themselves quite beyond the scope or tenure of the executive who authorized the investigation in the first place. Probing into his motivations in depth might be precisely the wrong thing to do if the consultant senses that the only justification for the study is ritualistic.
> …
> As a parting shot I will remind the authors of my insistence on a distinction between a conclusion and a decision. While this gap may be only inches wide, it is, in my opinion, a thousand feet deep.

Alderson's final line points to a significant element of the science-policy gap, one that led to Phillip Hammond's resignation as the chairman of the Scientific Committee for the IWC (Letter of resignation, 26 May, 1993. Cited in Friedheim, 1996):

> The matter of substance is, what is the point of having a Scientific Committee if its unanimous recommendations on a matter of primary importance are treated with such contempt.

Alderson's other comments point to what is colloquially called 'kicking the can down the road', that is, 'ritualistic' studies that keep the policy wheel turning but mean nothing overall. Alderson warns that if a study is trying to find a real 'solution to a decision problem' that scientists should be aware of the implications of a conclusion.

Beer comments about the dangers of science becoming involved in management decisions, evoking the handmaiden argument of Hodgson (1858) and the primacy of the policy (managerial) process:

> The management scientist faces, it seems to me, an ethical imperative. It is *to serve* the manager, because (for our purposes) the manager holds power as of right. If we, as men, seek to overthrow the manager, or to supplant him, or even to criticize him, we do so in the role of anarchist, or usurper, or commentator: … we must accept the appropriate role and the concomitant responsibility. But these activities are not actions taken qua researcher. There can be only one legitimate reason for undertaking research into decision-taking, policy-making and control – namely to improve the way these things are done. Since it is the managerial prerogative to do them, the researcher's role must be that of handmaiden.
>
> This position is taken, I repeat, is an ethical imperative. The concept of service, however, has to be interpreted. In the first place, I should not equate the role with that of an adviser. Suppose we say: 'course A appears to yield a 75% chance of $lm profit; course B offers a 90 % chance of bankruptcy. However, I am no more than an adviser: you must take the decision'. Clearly the decision is nugatory. We researchers very often take decisions, although we say we do not, in modelling the situation as we have modelled it, in selecting the evidence as we have selected it, in using the particular techniques of analysis and synthesis that

> we have used. It is important to note that the manager who accepts my proposal accepts *me* more definitely than he accepts the proposal as such. Therefore, to cut out of the implementation phase is immoral.
> On these bases, I think that the separatist position ought to be discarded outright. The separatist can exist only as an academic observer of the field (*ars gratia artis*). Moreover, he can by definition be no more than a poor management scientist. For management is *about* change, *about* successful implementation. If the separatist is genuinely separate, he can know no more of the situation than can the physicist who seeks to know the characteristics of a particle without in some sense observing it. If he does observe it (I invoke Heisenberg) he changes the situation; he is therefore not a separatist. The separatist position, it seems, is methodologically absurd as well as socially unethical.

Interestingly, Beer appears to be contradictory, beginning as an 'honest broker' that is; '*to serve*' the manager (policy), but resiles. Beer then argues that while (science) advice is supposed to be separate from (policy) decision, it cannot. Therefore, science must drive policy (*sensu* Brundtland, 1997) so that 'the separatist position, it seems, is methodologically absurd as well as socially unethical.' This is an argument for integration of the researcher into policymaking. This idea of 'mutual understanding' or integration is followed on by Bennis:

> The authors believe that rational answers fail to become real solutions to problems unless the user of research is willing to understand and adopt the research findings. The position taken by the authors is that "mutual understanding" between researcher and manager is the only true, though possibly least comfortable, path to the effective utilization of research. This sounds like pretty mild stuff at first glance, something akin to One Worldism and Brotherhood and all the other eternal verities. But what the authors mean by mutual understanding is radical and goes deep. They argue that the main blocks to using the results of scientific effort (implementation) are the "unconscious" and "politics," commodities which are liberally available in all shapes and sizes in both the scientific and business communities. Mutual understanding comes about through a process whereby researchers and managers turn inward and recognize these problems and resistances in their own universe before they begin contemplating and manipulating the other.

Bennis continues on to emphasize the elements of trust and empathy in the relationship between researcher and manager. Communication is the theme taken up in the comment by Evan, 'Nevertheless, the communication barriers between staff specialists and line executives, as Churchman and Schainblatt point out, are formidable. Communication barriers arise, in part, because of value conflicts and personality conflicts.' In terms of the science-policy gap this equates to cultural differences and lack of dialogue.

The next comments deal with communication and also mention the problem of uncertainty in making management decisions, the overall position being that the 'mutual understander' is the type will best bring about the 'union' of researcher and manager.

Churchman and Schainblatt ended the commentaries by observing that their use of the word 'understanding' may have been confusing to readers and then linked understanding to trust. With understanding, they argued that trust is not completely necessary and so 'mutual understanding' challenges the traditional barriers and roles of scientist and manager; when each understand each other there is no need to build trust and other parts of a working relationship. It is a simple functional role, with understanding each can function efficiently without any other relationship.

The key here is efficiency, while I am pointing out elements that fit the science-policy gap paradigm, Churchman and Schainblatt and the other commentators were concerned with business and how to bring the results of research efficiently to market. Although they do mention the function of government research agencies that is again in the context of efficiently bringing research to fruition (e.g. a better nuclear device) indeed one commentator, Hanssmann, was confident that; 'As far as the physical sciences are concerned, mutual understanding between management and science may be said to exist.'

These writers were, however, not navigating the function of environmental policies or policies relating to marine living resources and how these are contested by various actors, often using science.

This theme was taken up by Lieserson (1965) who emphasized that: 'the fact that the content of so many political decisions has become heavily scientific has not yet produced a transformation (or adaptation) of governmental decision-making processes to the scientific model for resolving conflicts of opinion, interest or power.' Lieserson considered that science is not structured and doesn't act in the sense of a political constituency or interest group. For him the usefulness of science to government was 'objective skills associated with the control of the material environment' (recall Benjamin Franklin). Leiserson concluded the role of science in policy is:

> Science and scientists are represented in the political and governmental order because of their utility (one might say *indispensability*) not because of their omniscience or correctness of judgement. … It is most interesting to observe the parallels between the recent thought about the contributions of the military to policy and that of the scientists. The contemporary emphasis in both fields seems to be upon *professional objectivity* and *balance* in the presentation of the technical *i.e.* the military or the scientific factors and viewpoints, along with the political, economic or moral aspects of a particular policy problem. If then, to adapt Huntingdon's terminology to another context, *high professional objectivity* is associated with *low political* (electoral) *involvement* and *high popular prestige*, the contemporary relations between science and government would appear to be consistent with a long-standing American tradition.

The 'long-standing tradition' is hearkening back to the 'handmaid role' of science as a tool in support of government activities; with science being objective, impartial and advisory. A similar approach was taken by Mesthene (1964), in lauding scientists making policy in the US after World War Two, when 'the quick succession of fission and fusion and missiles and moon-shots left the traditional policy-making machinery rather groggy, unable to deal with a new generation of unfamiliar policy problems.' This follows on from Conant (1950) and Price (1959) when they discussed the privileged role of science in the service of the government. Mesthene argued that scientists may not make the best policymakers, as Linstead did in 1948. Mesthene concluded that there must be a change in the relationship:

> … professional policy makers must first become more adept than they have been in dealing with issues that touch science before the government can safely lessen its encroachment on the scientist's time. It is not clear that physicists and chemists have to be in the policy-making jobs, but it is clear that these jobs must be manned by people who know what physicists and chemists do when they do physics and chemistry.
>
> The modern public servant, in other words, has to be scientifically literate. He must be able to understand a scientist when he talks. He has to be able to sift good from bad scientific advice. He has to be able to make his superiors in the Executive branch and in the Congress understand what science is really about, understand that it is more than modern sorcery. He must also be able to explain government and its special problems to the scientist, so that the scientist can provide more relevant advice to the government. He must function as the communications link, missing up to now, between the professional scientist and the professional politician.

It appears that at this time there was a move to reduce the policymaking influence of scientists in post-war America, to make the roles more separate and to consolidate policymakers as the power and scientists as advisory 'honest brokers'. This position of separation is the opposite of 'mutual understanding' for efficiency and today forms part of the science-policy gap. It also indicates a developing tension between the two, whereby science while held in high esteem and once being let into the policymaking room, is now being asked to leave and to only supply advice upon request. The policymaker would be the conduit for scientific information and would make the decisions on what science advice to accept or reject.

The 'implementation problem' surfaced again in 1967 in a paper by Dyckman. In a survey of managers and operation research workers, they concluded that mutual understanding was the way forward and that building trust and better communication would help resolve the implementation problem 'in the short term'. However he reported that he was 'disturbed' that a large number of respondents favoured the 'separate functions' position, which is essentially the position of Leiserson, Mesthene and Pielke, Jr.

In 1971, Sir Eric Ashby delivered the Bernal Lecture and his topic was: *Science and Antiscience.*
Sir Ashby began with a paradox:

> My theme starts from a paradox: the crisis of disillusionment in western affluent societies was the successful landing of a man on the moon. Until then large numbers of people were still prepared to believe that the social benefits of science and technology were largely fortuitous and the disorders of society were largely inevitable. But at that point people realized that a wealthy nation could mobilize enough skill and money deliberately to solve an incredibly difficult technological problem. At the moment of triumph there was criticism, not of the achievement but of the goal. Many Americans (wrote Harvey Brooks 1970) regarded walking on the moon as 'an arrogant piece of conspicuous consumption'. If this is what a sustained effort of planned technology can do, why is planning not successfully applied to other goals: why not to the transport problem in cities, or to poverty, or to the relief of the Third World?

Sir Ashby answered this with a question:

> So we are faced with a problem which is easy to state but hard to analyse: Is it part of the social function of science to determine goals?

The fear of the antiscientists, Sir Ashby explained, is not science itself but of the effects of science and the direction of science. As Sir Ashby put it, '…that the scientific method can speak authoritatively about means in society, but it cannot be authoritative about ends. There is no straight path from fact to value. If we rely on science alone, questions of purpose will not be answered; and politics are about purpose.' The ends of science were a great concern and both in the UK and America there were proposals for oversight committees to examine scientific results for unwelcome effects before they were allowed to be used. A kind of 'precautionary principle' for scientific research. This fear was apparent in the US in a news report (Anon, 1966):

> **Science and Technology Need Careful Watching**
> A FEDERAL "early warning" system to spot the "dangerous side effects" of technology before they become "serious national difficulties" was proposed by a Congressional Subcommittee. "Science and technology are amoral," it was charged in a report by the House Subcommittee on Science, Research and Development. Without proper scrutiny, "we may strangle in the coils of an unplanned, unwanted, but unstoppable technocracy."

The concern was about what might happen if science set its own goals instead of being 'mission-oriented' and directed by an extrinsic factor not set by science (see also Perl, 1971). This attitude developed in the public during the social changes of the Sixties, Earth Day, and Nixon's declaration that the Seventies were the 'decade of the environment'. So, as Sir Ashby commented:

> Anything which smacks of research into the future is bound to generate scepticism and invite contradiction; a good example is the speculation about the possible effects on world climate of carbon dioxide from fossil fuels.

The antiscience that Sir Ashby was talking about was not what is today called antiscience (in particular climate change denial), but a resistance to the introduction of scientific innovations into society with limited knowledge of its effects. Sir Ashby's lecture was given a decade after thalidomide deformed hundreds of babies, and almost a decade after Rachel Carson revealed the effects of pesticides.
At the same time there was much debate within society about the 'Blueprint for Survival', published in *The Ecologist* and the population/resources/environment model, *The Limits to Growth*, published through the

Massachusetts Institute of Technology. People at the time were also living with the ever present threat of mutually assured destruction by nuclear war. In a sense, the 'antiscience' feeling was similar to the distrust of science by general society after the First World War. Sir Ashby concluded:

> … that although it is not a responsibility of the scientist himself to set extrinsic goals for the deployment of science, it is his duty to educate others to set these goals and to influence the way choices are made. These choices will determine the future not just of science but of western society. I am not one of those who believe that regimes have to be upset and systems liquidated in order that the right choices may be made. I do believe that scientists can profoundly influence these choices through two activities: one, by making 'critical and pluralistic attacks on the problems of society', and two, by creating a climate of opinion about the use of science in social policy among those who will be flooding into universities and colleges in the 1970s.

Sir Ashby advocates that science engage in society and works on the problems society faces but not to set those problem solving goals. Science, he points out, 'should be on tap, but not on top'. The essence of this goes to advocacy and science led policy, or as Gro Haarlem Brundtland put it, 'there is no other basis for sound political decisions than the best available scientific evidence'.

In 1972, under the banner 'Only One Earth', the UN Conference on the Human Environment (The Stockholm Conference) developed 'Principle 21', an obligation on states not to emit pollution that effects the environment of other states and the global commons. This was, in large, the political result of the acid rain problem discovered in Sweden in 1968. While not legally binding it represented quite a rapid international response in going from science to policy.

Hopes were high and the *zeitgeist* of the time is seen in Strong (1972), who called for 'new attitudes and new skills to confront the present environmental crisis, and for a new partnership between science and politics':

> Man's capacity for self-destruction is most dramatically manifested by his creating and stockpiling weapons of nuclear, chemical and biological warfare; but the environmental crisis is now making him aware of the fact that he faces a threat at least as dangerous and even more pervasive from the very processes of industrialization and urbanization that have created such unprecedented levels of wealth in the industrialized world. It confronts him with the inescapable reality;
> …
> It is precisely this fact that gives the Stockholm Conference such urgency. It is a scientific gathering, but the proposals before it draw heavily on the wide variety of contributions made by the world's scientific community and a number of specifically scientific meetings which took place in preparing for the Conference. It is in the political sphere therefore, that its unique contribution lies. It is here that the Stockholm Conference – which stands at the interface between science and politics – must begin to construct the framework needed to deal with the new environmental realities, and to lay the foundations for the new dimension of international cooperation required by our environmental interdependence.
> …
> The political emphasis on Stockholm in no way diminishes or alters the need for science to provide many of the key answers to today's environmental problems. The scientist would be the first to acknowledge that thus far, relatively little of this information and advice on the environment has been translated into political action. Our hope at Stockholm is to help close this gap and to confirm the reality that a partnership of both – science and politics – is needed to produce effective results in order to preserve and enhance the human environment now and in the future.

In the last line one can see echoes of past hopes from the Nineteenth century to the early Twentieth. His other comments about partnerships are hopeful but represent rather unfocused ambit claims. At the same time, in America, Bickner (1972) considered that there would never be any such partnership:

> Since California has the necessary scientific resources, and since it has clear and urgent public policy problems, why isn't the Golden State ushering a Golden Age – the age of scientific policymaking and of scientific solutions to public problems? … First, though, we want to admit that we don't believe there is going to any such a golden age – ever. The prevalent hope for such a golden age is founded upon a couple of myths: one myth popular among lay citizens and the other popular among scientists. The first myth is symbolized by Aladdin's Lamp and the other is symbolized by Aladdin.
>
> Science may help us understand the world we live in, and scientific analysis of public issues may help us perceive the choices before us and recognise the consequences of our choices. But science is *not* an Aladdin's Lamp capable of conjuring up cost-free, trouble-free solutions to the many problems that confront us. All to often the lay public (and its political representatives) looks to science, not as a help in *coping* with hard problems, but as a devise for *escaping* them altogether. In California, as elsewhere, people appeal for "scientific breakthroughs" as an excuse to postpone responsible policy decisions and serious efforts.
>
> Scientists, as well as laymen, often expect too much of science. It is one thing to have a genie grant our wishes, but as Aladdin discovered, it is another thing to know what we want. At the core of social problems and public policy issues lie *values*, and science is never going to tell us, not in this millennium or the next, what human purposes and human values should be. The popular belief among scientists, particularly the more "rigorous" scientists, that they could guide the world "scientifically" if only given a chance, is a most *unscientific* presumption. It is a myth.

The two important ideas Bickner raises are firstly, the technocratic viewpoint of the scientific breakthrough as a solution. By this means negative impacts arising from science, such as chemical pollutants, can be fixed rather than by resorting to political or social means. The second is that science cannot decide human purpose or value, which accords with Ashby's position that science can only educate and offer guidance. This human purpose position was put plainly in a speech by the Research Director of Fisheries in Queensland, Australia. Sturman (1972) said:

> The administrator has a variety of measures to implement his policy objectives. In practice he is concerned not only with biological and economic factors but also with sociological and political considerations which may take precedence over the former.

This is a very common viewpoint and the opposite of Brundtland's statement and, as we shall see, in the specific case of marine capture fisheries and overfishing this viewpoint is not changing. Management of the ocean, especially the high seas, is a politically and organizationally challenging prospect as Johnston (1972/1973) points out in the case of marine pollution:

> Marine ecologists believe that the preservation of the ocean environment can be ensured by technically feasible adjustments and precautions in our use of the seas. Unfortunately, any effective combination of adjustments and precautions involves difficult organizational tasks that require unprecedented exercises of political will and novel feats of legal imagination. The vastness of the ocean and the interdependence of its environmental processes call for universal understandings on at least the first principles of marine resource development and conservation.
> …
> To the difficulties created by indifference, resentment, pride of sovereignty, multiple levels of authority, inherent complexity, and associated effects such as scientific uncertainty, must be added those caused by the diversity of factors affecting the perception and treatment of the problem. Disparities in the level of development certainly contribute to differences in attitude, priority, and capability.

The political, economic, and social factors as pointed out by the above authors are not to be underestimated as a driver of the science-policy gap. In 1974, Bernard published the first paper to directly address the relationship between scientists and policymakers, *Scientists and Policy Makers: An Ethnography of communication*:

> This paper is about scientists and policy makers and why they are so frustrated by one another's advice and demands. By scientists, I mean academic, research-oriented scientists, who take on advisory roles on a part-time, consultative basis only, and who view their primary career achievements as fundamental advances of science rather than as influences upon government decisions. By policy maker (or decision maker or bureaucrat) I mean action-level, career personnel whose job it is to interpret and implement policy as it is made by the executive branch of the government.

Bernard interviewed marine scientists and policymakers working on marine pollution issues. The policymakers were generally united in their perception that scientists were unaware of political factors in decision-making; had a lot of fine grain technical knowledge but couldn't 'package' that information in useful ways; and couldn't be drawn on definitive answers and there was little consensus on the science by scientists, summed up by one interviewee:

> If (oil) companies and other private interests say "no" to a policy and the scientists say "well, yes and no," the companies will win hands down every time. The trouble is, you can never get these guys [scientists] to agree on anything. They're always begging off, with the excuse that they don't have enough information to take a stand. They expect to just do what they can, give some advice on the state of the world as they see it, and have us take it from there. But every time I go to my boss with some evidence that supports a position I want to take, he says O.K., but the people at ------------ (names an oil company) have scientists that will tear that to shreds. So what do you do? For the most part you don't need scientific advice on most issues because they are really political issues. And even where you need the advice, all you ever get is conflicting information.

Scientists were equally frustrated:

> From their vantage point, the decision makers (1) ask the wrong questions; (2) pay little attention to the advice they get even when they ask for it in the first place; and (3) have very little appreciation of the power of objective information. Here is what a fisheries biologist said when asked why a particular species of fish had been removed from the endangered species list:
>
> > I don't know why anything happens anymore. People in Washington ask for advice and personally I don't see much relationship between what we [referring to fisheries biologists] tell them and what they do.

Bernard concluded that was a conflict of norms between the two, developing an ethnography of eight areas where these norms 'conflict', in short, they are:

1. In policy-making, positive value is placed on "making a decision" regardless of whether or not there is sufficient objective evidence to support the decision.
2. Science values truth and the unfettered search for truth.
3. Scientists and policy makers were seen in this field study as suspicious (even intolerant) of one another's career motives.
4. Scientists are encouraged to believe that rational information leads to the understanding of problems and to their ultimate solutions. In policy making, the experiences of the moment, pressure from higher-ups in the organization, and persuasive argument may *be* the rational data applied to problems.
5. In science emotional neutrality is the norm. Many policy makers, by contrast feel that "enthusiasm for an issue and emotional commitment to a point of view are essential qualities" in the bureaucrat "who really takes his public service mission seriously."
6. One of the absolute *musts* in science is what is called "colleague control". In bureaucracies, public or private, hierarchy is the natural order of things.
7. In science, we find a high value placed on the *communality* and *universality* of knowledge and truth. I have lumped them here because they clash with the same conflicting norm of the policy maker: nationalism.

8. Finally, consider the "norm of public service". Policy makers openly stated that they are "instruments of public will" and that their calling is to serve that will. Scientists claimed that their dedication to truth was tantamount to public service. Since "knowledge is beneficial to mankind," a scientist who pursues knowledge is performing a public service. For scientists the public constituency to whom one is responsible is mankind; for bureaucrats, the constituency is more pragmatically defined.

Despite this he found that scientists advising policymakers did work because the two groups attracted people who could work together and that they worked out a '*modus vivendi*' of compromise between their values. While both groups considered that they each were the group that had to compromise the most, Bernard concluded that the two were in balance.

This ethnography captures several of the elements in the present conception of the science-policy gap and his conclusions that maximizing the production and delivery of scientific data in a way that has the most impact and influence ('packaging') is one of the present day solutions suggested in the primary literature.

In the context of the frustrations of scientists (policymakers ask the wrong questions and ignore the results) and policy makers (scientists do not answer the questions that policy needs), it is worth remembering Confucius; 'If language is not correct, then what is said is not what is meant; if what is said is not what is meant, then what ought to be done remains undone.'

Science and politics was the topic of Brooks (1975) at a dinner address before the American Philosophical Society. His interest was how science gets caught up in politics and his words sum up the problem that scientists can have to today in presenting the results of their work:

> A profound change has taken place in the relation between the expert community and the political community in the last ten years. … Scientists today are listened to much more but believed much less than they were in those [post-war] heady days. There is still a great respect for learning among politicians and policy makers, but there is also much greater skepticism and suspicion, and the image of objective, "value free" science and scholarship is severely tarnished. … Scientists first became engaged at the high policy level of the federal government in defense policy, and later in the design of the space program, where their role was generally seen as evaluating alternative means to generally agreed upon ends, such as greater national security, or beating the Russians to the moon.
>
> Nobody's ox was gored, except for a few contractors or bureaucrats. But many of today's issues involve intense conflicts or apparent conflicts of values – energy supply versus environmental purity, clean air versus cheap personal transportation, equity versus excellence in education or health care. … But in the political arena tentative propositions or data can be highly dysfunctional when drastic political action must be taken in consequence. The situation is further complicated by the fact that political consequences can be strongly affected not only by the conclusions themselves, but by the particular way they are presented to the public.
>
> For example, my colleague at Harvard, Professor Michael McElroy, has encountered this dilemma in most acute form. He and his associates have been making model calculations on the effects of freon […] and of methyl bromide […] on the destruction of the ozone layer in the stratosphere. Since his calculations were published he has been beset by congressional committees and television talk shows, not to mention the research directors of industries that produce freon or methyl bromide. Cautions about the uncertainties in the present evidence, and the need for more research, are brushed aside as self-serving pronouncements aimed at getting research grants or blackmailing the chemical industry.

Brooks points to what was an increasing public concern, environmental effects and the contested space this created, as presaged by Sears (1955) and Johnston (1972/1973). Perhaps the most publicly visible issue at this time relating to human effects on the environment was the anti-whaling campaign started by Greenpeace in 1974 (Wyler, 2004), although scientists had been advising catch quota reductions since the start of the 1960s and the catch of blue whale was banned in 1967 (Andresen et al., 2000). After Carson, this issue represents the mainstreaming of environmentalism and the role of science. Brooks mentions the controversy surrounding ozone depleting chemicals, Carson was vilified by the pesticide industry (see also Marsh, 1999, concerning dugong conservation and fisheries) and Sears discusses the calls for science (here the AAAS) to take a position in a controversial public issue.

This rapidly growing tension between use and perceived abuse can throw the science-policy gap into sharp relief, particularly in relation to marine capture fisheries; consider the early management of whaling by the International Whaling Commission. While there is a long history of conflict in fisheries management, like the 1376 English petition, the 1499 Flanders trawl ban, the 1583 trawl ban by the Dutch and the 1863 Royal Commission into trawling (Roberts, 2007), or the 1946 London International Overfishing Conference (Cochrane and Doulman, 2005), by and large the purpose of fisheries management has been to maximize economic return. Advice given to the various policymakers relating to sustainability and impact mitigation, whether from within or without the management organization can create conflict of values, as Brooks discusses.

This conflict of values can be dangerous ground for a scientist working in the contested space. This was discussed by Stivers (1976) who identified three areas within the relationship between research and policy:

> *The scholar vis social problems*
> This debate focuses on criticism of scientists who have turned activist/advocate/social reformer, and the confusion created by a failure to distinguish and identify the role in which the scientists speaks at any given point.
>
> *The scholar vis the government*
> This debate encompasses two separate questions: Whether the researcher or the research may be compromised by the government's bias (the pressure to go beyond the search for truth to find a solution) and the conflict between science's need for a long-range approach and the government's need for a short-range solution.
>
> *The scholar as scholar*
> That science should remain devoted to the search for knowledge, whatever direction that may take, is an undisputed point in these debates.

In terms of the science-policy gap, she identifies two main factors; long-term and short-term objectives and the issue of compromise in government research, which is an issue of independence from policy issues. Both of these points were seen as critical by the respondents to my survey. Her first point raises a tangential issue for the issue at hand, the question of advocacy by scientists. The President of the Royal Society also touched upon the issue of the scholar vis the government in his Anniversary address (Todd, 1976):

> Much of the creative work leading to fundamental advances in science is carried out in universities and research institutions. … But today we are all too aware of the parrot-cry about the need for 'relevance' in academic research. Catch-phrases like 'cost-benefit analysis' and 'management of research' are bandied about and we are told of the need to orient research towards the fulfilment of national goals (these latter being, of course, determined by the particular political party which happens to be in power). This is ominously close to the direction of research on political grounds - a thing against which is an age of increasing political intolerance we must constantly be on our guard.

Todd also recognised that the changes in status, public perception of science, and the role of science makes it increasingly difficult for scientists to remain separate from public issues but advocates, like previous workers, that:

> But let us not forget that if scientists are to be accorded the privilege of tolerance and freedom from interference they must obey the rules. And these rules are most clearly expressed in my earlier quotation

> from Robert Hooke, in which he enjoins that there be no meddling 'with Divinity, Metaphysics, Moralls, Politicks, Grammar, Rhetorick or Logick'. To avoid meddling with some of these presents few problems but nowadays the scientist may find it less easy to keep clear of divinity, morals or politics. Yet if science is to lead to the advancement and not the destruction of mankind it must refuse to meddle with or be dominated by them.

Furthermore Todd said that the independence of science relies upon being removed from 'meddling' in issues of public concern. Interestingly, the Royal Society now has a policy centre and now will give advice on issues of public concern whether asked or not (see Rees, 2010).

Caplan (1979) highlighted and focused the use of the term 'gap' in relation to science and policy:

> IS THERE REALLY A GAP?
> The answer to this question is most certainly, "Yes". Recently, I directed a study (Caplan, Morrison, and Stambaugh, 1975) in which 204 upper-level executives in policy-influencing positions in the U.S. government were interviewed regarding their use of social science knowledge in policy-related issues. These respondents were carefully questioned to determine if they were in contact with an influential network of scholars, or "invisible college", with expertise in social science fields relevant to the respondents' area of policy responsibility. Responses to these items showed that no such liaison exists and that contact, formal or informal, between social scientists and upper-level decision makers is rare.

Caplan considered that the relationship between social scientist and policymaker can be explained by the 'two-communities theory', which he describes as similar to Snow's 'two cultures', summarizing this view and several other viewpoints, all of which can be found in present ideas about the science-policy gap:

> They [the two-communities theorists] argue that social scientists and policy makers live in separate worlds with different and often conflicting values, different reward systems, and different languages. … Some argue that the gap between the knowledge producer and the policy maker needs to be bridged through personal relationships involving trust, confidence, and empathy. Others see this gap as something apart from cultural differences. They stress conflict over who determines the ends of policy as an important factor that keeps the social scientists and policy makers apart.
>
> Some feel that the spectre of knowledge misuse by political power tends to widen the gap. Still others, particularly those who argue the need for "linking" mechanisms, see the gap as a communication failure or a lack of organized effort to systematically introduce social science knowledge in usable form into the policymaking process at the key points where it will most likely be used.

His solution was a closer, carefully structured, collaboration between knowledge producers and knowledge users. In 1981, Chatterton and Chatterton argued that, 'fisheries management policies reflect the outcomes of political processes rather than biological or economic considerations'. They examined several fisheries in South Australia. The ideological differences between political parties in power were causing swings in fisheries policy to the detriment both of the industry and the marine living resources. Their view was that the 'social democrat Labor' party with its rejection of freehold title and the sale of authorities (licenses) to fish in closed (limited entry) fisheries contrasts with the 'conservative Liberal' party supporting free-enterprise market systems and the sale of authorities in closed fisheries.

This changed management approaches according to which party was in power. Chatterton and Chatterton considered that this political conflict was causing artificially high values for authorities making local coastal fisheries owner/operators disappear, along with the economic base of those fisheries. This conflict swamped any policy considerations of fisheries management even though it concerned sustainable fisheries management at the heart of the matter.

'Bridging the gap' was a term introduced by Sebek (1983). His concern was that, 'A wide gap currently exists between the scientific assessment of environmental problems […] and their legal and administrative regulation and enforcement.' His test case was marine pollution control and he considered the gap between developing enforceable controls were a combination of the negotiation processes, political compromise, non-binding controls and lack of integration of science into both the finished instrument and during the process. His suggested solutions were:

> *Educational role:*
> The independent scientific community must find more platforms to popularize (without sensationalism) its findings to the media, the public, national parliaments, regional and global international agencies within and outside the United Nations system.
>
> *Planning the legislative action:*
> A closer liaison between the scientific community and policy-making bodies is also necessary at the planning stage of international legislation.
>
> *Participation by scientists in law making process:*
> It is important for the scientific community to achieve a better representation on governmental delegations at diplomatic conferences. Politicians often consider adoption of any agreement to be a successful outcome, whatever its deficiencies. Their rationale for this view is that "in a real world we must settle for what we can get".
>
> *Independent scientific advice to policy-makers:*
> It may be difficult to ensure that national governments receive independent advice since they not only rely on their scientists within civil service for briefings, but also use them for the inevitable bargaining process at diplomatic conferences and at intersessional meetings of international agencies dealing with environment. There nevertheless exists a need for a steady input of data and evaluations from the independent scientific community to relevant national and international bodies.
>
> *Follow up:*
> It is also necessary to establish appropriate procedures to check the progress made in the legal and political arena following adoption of relevant legal rules. This task is not easy in view of the traditional unwillingness of scientists to "meddle" in politics, and an equal traditional distrust on the part of civil servants of the views of environmental "technocrats" whom they consider to be insensitive to economic and political realities. Independent scientific research and industry: While the international law making process is subject to numerous constraints, much improvement can be made through promoting voluntary action by industry.
>
> *Environmental cost/benefit analysis:*
> It is necessary for scientists to work with economists more closely than before on the development of adequate theories concerning cost/benefit analysis and on placing a price tag on a clean environment. The paucity of such studies and the inevitable lack of sophistication in some of the existing theories have made it difficult for environmental priorities to compete successfully against those of industrial development.
>
> Finally, scientists should educate policy makers about the necessity of incorporating environmental considerations into development plans.

Sebek is arguing for a greater integration (cf. Caplan's 'collaboration') of science into the policy process rather than a 'separate function' or 'honest broker' approach (see: Ashby, Pielke Jr, Todd). Sebek argues for more science led policy development along with science being involved in 'procedures to check the progress made in the legal and political arena following adoption of relevant legal rules'. This is a far more proactive approach to science and policy but one he regards as necessary to 'bridge the gap'.

Sebek was looking at international controls of marine pollution and in a similar vein Andresen (1989) examined whether or not science had any effect on decisions made by the IWC. Andresen considered first that, 'new or more precise information may have minimal influence if it runs contrary to the perceived interests of the major players.' And then, secondly what types of 'interest criteria' are available for membership in the IWC and how those affect the scientific input.

To relieve internal political tension within the IWC, an external independent committee of three (later four) experts was appointed in 1961 to establish population assessments. In 1963 they reported back with advice for a complete ban on whaling on blue and humpback whales along with quota cuts. Andresen notes that it took five years for this to come into effect, with the main obstacle being Russia and Japan demanding more scientific data; observing that while the expert committee's research was gradually being accepted as correct, when the reduced quotas were finally accepted it was only because the whaling nations could not catch enough whales to reach their current quotas. Even though the scientific information carried more weight, Andresen considers that may not have influenced the whaling nations.

Similarly, by the 1970s the Scientific Committee of the IWC (SC), apparently had a strong position within the IWC and increased the weight of scientific biological considerations. Andresen observes; 'However, the reason its position had strengthened might not *only* have been the weight of the scientific argument. Of equal significance may have been the reduced economic importance of whaling. It is easier to abide by scientific recommendations when the material stakes are no longer high.' This very relevant for all current fisheries.

By the late 1970s, the push for a moratorium was gathering strength and Andresen cites an observer who noted: 'Scientific input to the meetings is improving and becoming more sophisticated … (however,) that does not make much difference to the political decisions – as yet.' There were many differing positions leading up to the 1982 moratorium and it would do well to consider Stivers (1976) comments about advocate scientists and appreciate the fine line that the SC and associated scientists must have been walking. When, in 1972, a ten year moratorium was first proposed at the Stockholm Conference, the SC saw no scientific justification. Andresen asks; 'Did new scientific evidence indicate that some kind of moratorium was needed a decade later, or was the call for a moratorium primarily politically based?'

In 1982, the SC played no role in the push for a moratorium and made no recommendations. Andresen notes; 'although many scientists favoured the 1982 decision, some of them very reputable (but often with strong anti-whaling views), basically it seems to have been a political decision. The large majority of nations in the IWC, for various reasons, simply wanted no commercial catch of whales.'

Andresen concludes that, 'The future the whales and whaling will, however, not be decided by scientists. … As to the main questions dealt with in this article regarding the relation between science and politics, the past decade clearly confirms that policy variables are dominant.'

This echoes the comments of Kelsen (1951), about how science can be turned to the use of politics, or ignored. This is far from the present hopes of science-led marine policy which can be enacted, in aspiration or practice, but ultimately is subservient to politics and economics.

1.3 Conclusion

In this chapter I have very briefly drawn out the origins of the science-policy gap in a wider societal context; how science has related to politics; and the appearance of themes within the science-policy gap. Below, tables 1.2 and 1.3 details some pre-1990 causes and solutions.

If one accepts that the earliest trace of the science-policy gap lies in the 17th Century and the birth of modern science, then the opinions seen in table 1.2 are clearly examples of what Hooke and Franklin sought to avoid by separating scientific research societies from the political world; the use of science by partisan politics, the conflict of values and sometimes the disregard for objective science in policy. This long separation has seen 'the two cultures' lacking ability to communicate.

Table 1.2 Some causes of the science-policy gap suggested by various authors pre-1990.

Year	Cause	Author(s)
1959	The Two Cultures.	Snow
1965	The 'Implementation Problem'.	Churchman and Schainblatt
1965	'A distinction between a conclusion and a decision. While this gap may be only inches wide, it is, in my opinion, a thousand feet deep.'	Alderson, in Churchman et al.
1974	'Many of today's issues involve intense conflicts or apparent conflicts of values'.	Brooks
	'From their [scientists'] vantage point, the decision makers (1) ask the wrong questions; (2) pay little attention to the answers they get even when they asked for it in the first place; and (3) have very little appreciation of the power of objective information.'	Bernard
1976	Science – tendency to provide ambiguous answers; Policymakers – unrealistic expectations of science.	Stivers
1979	The 'Two-Communities Theory'; 'Conflict over who determines the ends of policy'; 'the spectre of knowledge misuse by political power'; 'the gap as a communication failure'.	Caplan
1983	'A wide gap currently exists between the scientific assessment of environmental problems […] and their legal and administrative regulation and enforcement.'	Sebek

Table 1.3 Some solutions to the science-policy gap suggested by various authors pre-1990 as practical ways of reducing the gap.

Year	Solutions	Author(s)
1950	'Judicial process' to resolve differing expert opinions over a particular scientific issue.	Conant
1955	'Major problems be referred to impersonal, disinterested, and competent boards of scientists' [for resolution].	Sears
1964	'The modern public servant, in other words, has to be scientifically literate. … He must function as the communications link, missing up to now, between the professional scientist and the professional politician.'	Mesthene
1965	Mutual understanding.	Churchman and Schainblatt
1967	Building trust, better communication, mutual understanding.	Dyckman
1974	'Information packaging'; production and use of science in a comprehensible, useable, and influential way.	Bernard
1979	Greater collaboration between researchers and policymakers	Caplan
1983	Educational role: Planning the legislative action: Participation by scientists in law making process: Independent scientific advice to policy-makers: Follow up: Environmental cost/benefit analysis: Scientists should educate policy makers about the necessity of incorporating environmental considerations into development plans.	Sebek

One theme seen in this chapter is distrust between politics and science which has repeatedly seen science as a process that must be under the control of government (e.g. Eastman, 1897; Merriam, 1946; Conant, 1950; Kelsen, 1951; Lieserson, 1965; Todd, 1976). The perspective often seen here, from the beginning of the 20th Century to present, is that science is to be a tool, or function, of government and that it has no place at the policymaking table (e.g. Conant, 1950; Price, 1959; Mesthene, 1964; Ashby, 1971; Bickner, 1972).

These early discussions had another similar theme, that of values. What are the values of scientists? The policymakers? An early example of this is seen in Cockerell (1920) (Fig. 1.1). This theme was revisited by Snow (1959), Ashby (1971), Bernard (1974), and Sebek (1983). These two themes are reflected in public concern over the effects, or use, of science in society (e.g. Campbell, 1915; Sears, 1955; Anon, 1966; Johnston, 1972/1973; Brooks, 1975) although they are counterbalanced by optimism (e.g. Miller, 1903; Strong, 1972).

This mixture of distrust, values, and the role of science coalesced in the research dialogue in the early 1970s, particularly in the work of Bernard (1974) and Caplan (1979); who asked, 'Is there really a gap?', and the answer was yes. The main solutions presented were understanding (distrust); communication (values), and education (the role of science), as seen in table 1.3.

In the following chapter, I continue tracing the science-policy gap in the primary literature and draw the main dialogues into three thematic discourses: The science-policy gap, political interference, and uncertainty. Post-1990, workers who engaged with the problem of why policymakers were not reflecting the considered advice of scientific research firstly enquired as to the nature of the gap, then a relative minority placed the gap in a political context, while others mainly focussed on the cultural differences between science, information, and policymaking.

2 The progress of the science-policy gap in the primary literature: Post-1990

2.1 Introduction

In this chapter I follow the development of the science-policy gap as it separates into three distinct themes by the mid-1990s. In the previous chapter, I showed that some of the major themes of the science-policy gap have existed over the past centuries. The discussion sharpened in the 1960s to the 1980s and the gap became a term in use, with identified causes and suggested remediation. While this discussion was largely about the relationship of science/policy/society, it began to become more focussed, particularly with the work of Bernard (1974), Caplan (1979), and Sebek (1983). Post-1990s the discussion became more refined, possibly as part of the rise of 'science and technology studies', more social science interest in science and policy, and latterly 'post-normal' science hypotheses. By the mid-1990s, the discussion can be placed into three main themes relating to the science-policy gap; political interference, uncertainty, and the science-policy gap itself. This chapter shows the developments I describe above and draws the discussion into these three main themes.

2.2 1990 – 1995

In 1990, a special edition of *International Challenges* focused on the use of science in international resource management. In one of these papers, discussing the International Council for the Exploration of the Sea (ICES), Fløistad (1990) made some observations that neatly capture what I consider to be a dynamic that is not only crucial to the science-policy gap but fisheries management itself. Fløistad called the relationship between science, fisheries, and fisheries management as 'out of step'.

Owing to technological and efficiency improvements in fishing gear and methods, science is lagging behind the technology. By the time science has established the effects the fishery may be having on fish populations and ecosystems, management is lagging behind science. Fløistad was considering the management lag from the perspective of over-exploitation resulting from technological innovation.

From this viewpoint, management has set allocations or quotas and then a technological fishing improvement occurs. By the time the science has found a deleterious effect, management is then put in the position of having to reduce catches for that fishery, but there may be no political or economic will to do so. This can then bring the science into contested space, also known as the SEK-TEK debate; scientific ecological knowledge versus traditional ecological knowledge – the fishers knowledge against the scientific assessment.

Finally, Fløistad points out another effect, whereby science comes to be 'lagging behind management requirements'. In this model, policy for management is changing as ecological awareness increases, for example, the movement of policy towards ecosystem based management (EBM) rather than single population management. Policy needs are moving ahead of the information that science can provide. The thing to note here is that science and policy are playing swings and roundabouts in terms of mitigating over-exploitation and in preventing over-exploitation. Conceptually, this can be considered as an underlying tension in the science-policy gap.

Fløistad suggested that the situation could be improved with better communication and dialogue. While Andresen (1990) and Wettestad (1990) in considering international resource management concluded that in international regimes, such as CCAMLR and the ICES, science is directly subordinated to the political process; emphasizing the 'separation' of science from policy, as supported by Todd and essentially rejected by Sebek. This is an effect of the role of national interests in negotiations, as mentioned by Bernard and also Johnston. In international negotiations the 'coordination' of scientific data between parties is an important factor as is the legitimacy of the science. Communication of science, especially to non-scientists (e.g. negotiators) is another critical factor in reducing the distance between science and policy.

The other theme in this period is the role of science in environmental protection. While in past years the discussion had ranged from science as a social and political force and the use of science in setting international and national policies, this discourse set into the process of science being used in established policies. Although this had been a part of the previous discussions, the focus over the next years became more on the function of science in established policies as well as the more general relationship between science and policymaking. The change in emphasis from the post-war 'endless frontier' to the decade of the environment clearly was not easy given the contested spaces in natural resource exploitation and the clashes of values inherent in this. The role of science was criticized by de la Mothe and Dufour (1995):

> The scientific community … has for decades promised the public and politicians far more than it could deliver. The 'endless frontier' of science has not managed to translate itself into an 'endless solution'.

Constable (1991) points out that fisheries management has persistently failed to prevent collapses despite various policy approaches; proposing a proactive approach to management in which a suite of alternative management models are assessed scientifically before any activity is allowed to commence.

A slightly different approach was put by Meffe and Viederman (1995). They considered that science should engage in the policy process by establishing issue driven science that is cross disciplinary from then policy can be influenced by 'focused advocacy', based on solid evidentiary science ('data quality rather than quantity'), to drive the policy results. Brosnan (1995) generally supported this position, using the cross disciplinary development of the Oregon Territorial Sea Plan as an example. She considered the key for success was better communication and the better understanding of ecology by policymakers and lawyers that resulted. Williams (2007) made a similar comment. This implied a better integration of science into the policy process. Integration was the objective of Brown, Jr (1993); although he was concerned that successful integration may be thwarted by partisan science. For him, objectivity in science was the paramount goal and from there science would be accepted and integrated into policy more easily.

2.3 1996-2000

Three main themes were prevalent in this period; the ongoing discussion about the science-policy relationship; political interference in the science-policy relationship; a discussion about uncertainty as an issue in policy and science.

2.3.1 The science-policy gap

If one considers Tables 1.2 and 1.3, many of these themes continue down the timeline. For example, there was a position for Mesthene's scientifically literate manager as being critical to the success of policies (Risk, 1999). Integration (communication) between science and policymakers was again seen as a vital part in the relationship (Berry et al., 1998; Clark et al., 1998; Newton, 1999; Pouyat, 1999). Pouyat also referred to cultural differences, differing time scales between research and policy, and the political perception that confuses ecology with environmentalism as contributors to the science-policy gap. While Berry considered polarization and fragmentation of research and policy development as a problem; 'Everything is one giant collage with everyone pushing their own agenda'. Interdisciplinary, collaborative, research programs that draw different research fields together was also a direction seen as important. Research that was applied to the policy question, 'mission oriented' or 'top-down directed', was another factor seen as important for the successful meeting of science and policy (Schubel, 1997; Berry et al., 1998; Clark et al., 1998; Lewis, Jr 1999).

2.3.2 Political interference

I am using the term 'political interference' in a very pragmatic sense, as this was a term used by my survey respondents (similar meanings used; 'political expediency', 'political agenda', &Co.). It is also a term used in the primary literature. The sense I gained from the respondents was that there was a common understanding of 'political interference', not explicitly defined - but one knows it when one sees it.

Hoel (1998), who examined the effects of the rise of environmentalism in international fisheries agreements used the term 'outside influences'. This is also a sense that I gained from my survey respondents. Hoel was concerned with environmentalism, but for my purposes the scope is broader. Political interference (outside influences) in this context generally involves policy that has a purpose and the actors know that purpose. Political interference can then include government, or bureaucratic actors working on the government's behalf, controlling scientific information to their agenda (Hutchings et al., 1997; Spurgeon, 1997). Caplan (1979) made a similar point.

This does not have to be subtle. Political interference can also include the involvement of commercial or environmental interests, or, in the case of Marsh (1999) personal attack by a wise-use group. Other interests can also operate as political interference. Science can also be seen as political interference in the established order, if research results challenge established policy directions or business activities and are not welcome (e.g. CFCs and ozone in Brooks, 1975). Whatever the form, or lack, of political interference, in the end policy decisions are political (Haward, 2000).

2.3.3 Uncertainty

Fisheries biology has been described as counting trees, but the trees are invisible and they move around. Likewise, marine capture fisheries have been described as, 'Like trying to harvest potatoes from a balloon with a long rope and some gear at the bottom, and a cloud between you and the potatoes' (Burdon, 1972). Both fisheries and fisheries biology have spent many years trying to improve their capacity to 'see' the fish for a similar purpose; to maximize economic returns without depleting, or over-exploiting, marine life. This effort has generally failed.

Uncertainty enters both fields. The fishing industry faces operating costs and the uncertainty here is whether or not they are catching to little for 'catch per unit effort' (CPUE) to get an effective return. The understandable tendency here is to fish as hard as possible as effectively as possible to maximize CPUE, which at the beginning of a new fishery where there is little population information makes economic sense; this is in essence the 'boom-and-bust' cycle (see Lack et al., 2003). In some fisheries, that may have experienced boom-and-bust, the industry may be concerned with longer term economic return (e.g. the West Australian rock lobster fishery), so the interest turns to maximizing economic return without depleting the resource in the near present; that is, in the absence of temporal, stochastic, and exogenous factors. However, at the same time industry players are understandably engaged in competition to maximize the profit and minimize the costs of their business, leading to the efficiency innovations that Fløistad (1990) identifies as leaving science 'lagging' behind fisheries impact.

Fisheries biologists remain in the position of counting invisible moving trees. In the situations described above, they have at least four roles. Firstly; in a new fishery is the catch quota set too high, indicating over-exploitation? Secondly; is the catch quota too low, indicating a fishery that is not at maximum economic yield? Thirdly; has technological innovation (or IUU activities from within, or without, the fishery), changed the ecosystem or population structure and so the maximum economic return without depletion of the population? Fourthly; is the fishery experiencing environmental or community change, such as interdecadal synchronicity, which could radically and perhaps rapidly change the population and ecosystem structure and the risk of over fishing?

Four decades ago, in Australia, fisheries management was defined as 'a policy designed to develop the industry at a rate consistent with discovery and demand. Such a policy should be aimed at the maximum utilization of the various resources without depleting the stocks' (Ellem, 1972). Conservation was defined by the International Conference of the Law of the Sea as, 'the maintenance of maximum sustainable yield' (Hancock, 1972), these definitions have very slightly altered but historically have infixed fisheries as taking as much marine living resource as possible, putatively without depletion – absent uncertainty as the ideal.

This is the core purpose of fisheries biology and management. However, there is always conflict between economy and ecology. In the West Australian rock lobster fishery, the historical three-inch minimum carapace length for legal catch was both the acceptable marketable size and the crustacean's reproductive size (Hancock, 1972). The question is which is the most important?

Uncertainty as a factor in the science-policy relationship was a focus in this period with even a theme issue on the topic published by *Marine Ecology Progress Series*. In terms of policymaking, scientific uncertainty about the effects and impacts of human actions on the marine environment has been considered as a more powerful force creating inaction than direct lobbying (Brown, 2000). I separate scientific uncertainty into two factors broadly at work here: operational uncertainty and effect uncertainty.

Operational uncertainty can be considered as the suite of uncertainty factors within a fishery related to maximum sustainable yield (MSY), and the operation and management of a fishery. Science and policy are capable of working closely, often with the cooperation of industry, to resolve or refine questions of uncertainty relating to the population in question.

Effect uncertainty relates to the effect a fishery may be having on the marine environment and ecosystems. There is some overlap with operational uncertainty, as many fisheries management policies have actions directed towards, for example, certain levels of bycatch. However, it is in the area of effect uncertainty that the gap is more likely to open. Fishery effects on bycatch, endangered species, environmental and ecological damage, and effects on ecologically related species (ERS) can, and nearly always do, have scientific uncertainty attached. In a policy sense, uncertainty can be used to argue for inaction until a definitive effect is seen, or it can be argued in a precautionary manner. Uncertainty can also lead to inaction because policies can have legally defined trigger points which can make it difficult to take action in the face of uncertainty, for example, in deciding if a species is 'depleted' (Taylor et al., 2000; Slooten et al., 2000). Effect uncertainty can be used as a tool to argue for or against an action, however, this can be confusing for the general public when confronted with competing scientific claims about an issue while being largely ignorant about scientific method and scientific uncertainty (Dovers and Norton, 1996; Bradshaw and Borchers, 2000). Indeed, as Healey (1997) points out:

> In any significant policy decision a wide variety of interests will compete for influence, and each interest will exploit scientific uncertainty and the diversity of scientific opinion to legitimize its preferred policy option.

2.4 2001-2005

2.4.1 The science-policy gap

There were three major conferences devoted to the science-policy gap during this time: 'Bridging the gap' (Axell, 2001), held in Stockholm, 2001; 'Bridging the Gap' (Anon, 2004), held in Dublin, 2004; 'Science meets Policy 2005' (Anon, 2006), held in London. There was also an 'Inaugural Roundtable on Science-Policy' held by the Institute on Governance in Ottawa (Anon, 2005). For brevity, below I have tabled the main factors/comments as they relate to the science-policy gap (Tables 2.1, 2.2, 2.3 and 2.4). It is worth reading over them while keeping in mind the factors described above, from the Nineteenth century to present. The Stockholm conference was held as part of the Swedish EU Council Presidency and the theme was sustainable development and the environment.

Table 2.1 Science-policy factors from the Stockholm 'Bridging the Gap' conference, 2001. These quotes come from the rapporteur's published report of the conference and are quotes of statements made by participants or from notes made of discussions or conclusions in conference sessions.

Page	Rapporteur's notes
2	'As a policy-maker I can try to protect the environment but it is up to you in the research community to make sure I can do this in the best possible way.' – EU Environment Commissioner Margot Wallström.
9	Others argue that ours is a society driven by technology and technocrats and that a new type of governance is needed.
9	'Political representatives cannot rely on isolated specialist groups.' – Programmes Director of the EU Joint Research Center, Professor Lena Torelli.
11	… Science should be responsive, policy relevant, address the issues and provide options.
12	There is a worrying communications gap – and a need to improve the flow of scientific knowledge to both civil society and policy-makers.
12	Science and its practitioners, at times cocooned in their disciplines, should be aware of uncertainty and ignorance, aware of other actors, cultures and options, and policy relevant.
19	Gaps in knowledge within the research community (e.g. between economic and environmental studies) are as significant as gaps between the research community and policy makers
19	Much research is too complicated or onerous for decision-makers to be able to address.
20	Research cannot make a contribution to policy unless the policy community has the capacity to engage in the issues being investigated by research.
24	'We want the research community to deliver robust and applied research.' – Rolf Annerberg, Head of Cabinet at DG Environment.
26	A greater awareness among researchers of those areas in which decision-makers need help, as well as a better understanding among decision-makers of the conditions and restraints on researchers. – Chairman's conclusions.
27	The biggest gap exists between commitments and implementation, not between research and commitments. – Chairman's conclusions.

The main theme to occur here was policy relevant science that is applied and understandable by policymakers, combined with better communication and scientifically literate policymakers. The last comment by the Chairman is almost a paraphrasing of Alderson (Churchman et al., 1965): 'As a parting shot I will remind the authors of my insistence on a distinction between a conclusion and a decision.' – 'The biggest gap exists between commitments and implementation.'

The Dublin 'Bridging the Gap' brought together 350 delegates from 37 countries and relevant international organizations. The conference was held as part of Ireland's EU Presidency. The focus of the conference was: 'The need for better linkage between, on one hand, monitoring, reporting and research, and, on the other, the policymaking process.'

Table 2.2 Science-policy factors from the Dublin 'Bridging the Gap: Information for action' conference, 2004. These quotes come from the rapporteur's published report of the conference and are quotes of statements made by participants or from notes made of discussions or conclusions in conference sessions.

Page	Rapporteur's notes
3	Integrated multidisciplinary research is needed for better analysis of policy conflicts and for a more comprehensive assessment of impacts on the environment.
6	To bridge the information gap from both directions. Knowledge must influence policy, and policy must guide the monitoring, reporting and research strategies that produce the knowledge.
22	Good science remains the basis for robust policy development.
23	A key issue in addressing the policy processes at the local, regional and national levels is the uncertainty that limits many regional models and studies … Such uncertainty can also compound the institutional barriers that exist in some cases, providing a rationale for continuing inaction.
25	… It is important that the main knowledge and communication gaps between reality, research and effective policy actions be identified and closed.
30	Communication between scientists and policymakers is best by particular challenges, and communication between policymakers and the public faces different but related difficulties.
35	'The large volumes of data often reach flood proportions – and this is not what policymakers require. Information must be not just available, but also accessible and relevant.' – Chairperson's conclusions.
36	'Improvements in communications are needed: between science and policy; and between ourselves (scientists and policymakers) and the public. Clearly, if we are to have effective policymaking, communication must work well in both directions.' – Chairperson's conclusions.
36	'The policy response to major issues at all levels must be evidence-based. The information presented to policymakers must not only be scientifically sound but also presented in a succinct, credible and convincing manner.' – Chairperson's conclusions.

The theme developed here was again better bidirectional communication based on good science that is robust, scientifically sound, and delivered in a succinct and convincing manner (cf. the 'packaging' idea in Bernard, 1974), leading to effective policymaking that is evidence based. The 'Science meets Policy 2005' conference was held in London as part of the UK's EU Presidency. The conference was attended by 80 scientists, policymakers, research managers and 'various kinds of science-policy "translators"'.

Table 2.3 Science-policy factors from the London 'Science meets Policy 2005' conference. These quotes come from the rapporteur's published report of the conference and are quotes of statements made by participants or from notes made of discussions or conclusions in conference sessions.

Page	Rapporteur's notes
iii	'It is important that we communicate science in an appropriate and accessible way to policy-makers if we wish to find sustainable solutions to environmental problems.' – Sir John Lawton.
1	Funders to require dialogue between researchers and policy-makers be part of the design of research projects.
2	Build training on communicating with non-scientific groups into scientists' education.
2	Build awareness of policy processes and needs into scientists' education.
2	Educate policy-makers on the use of scientific evidence in policy-making.
2	Create a framework to improve and promote the use of science skills for policy-makers.
2	Create science-policy secondments to allow policy-makers and scientists to gain experience working in each others setting and create active, personal working links.
2	Support long-term and independent research.
3	Researchers should seek out policy 'mentors' who can help them create links into policy networks.
3	Researchers need to gain an understanding of how policy processes work.
4	Uncertainties in research results need to be acknowledged and clearly identified.
8	Dialogue between policy-makers and researchers is not only helpful to improve the research process; it is also critical to the policy process.
10	Those involved in policy need to develop processes for identifying their research needs…
10	Where research is specifically being developed to assist policy, additional criteria relating to policy relevance, timeliness and usefulness need to be developed and put to use it the research is to be 'fit for purpose'.
13	Policy-makers need to be able to persuade their constituencies that an issue is important. Therefore, they need to be presented with 'strong science' in a meaningful way.
14	The need for greater inter-disciplinarity has been consistently identified as a priority for creating knowledge that is valuable for policy.
14	Researchers need to ask relevant constituencies 'if we are doing research in this area, what questions would you want answered?'
17	We need to continuously refine our research needs and to enhance dialogue between the research and policy communities.

Dialogue was the central theme at this conference. As well, a desire for greater understanding through education of scientists about the policy process and *vice versa*. The idea of 'secondments' whereby scientists and policymakers would gain work experience in each others environment was proposed, and this idea was a strong theme among my survey respondents for this thesis. Policy relevant science, either from researchers asking for direction or from policymakers properly identifying research questions was a factor and a multidisciplinary approach was seen as one solution.

The [Canadian] Institute on Governance held an 'Inaugural Roundtable on Science-Policy' in Ottawa, 2004. The following is from the revised version of the summary report, 2005. It brought together 15 people, a 'small and diverse group of experts'.

Table 2.4 Science-policy factors from the 'Inaugural Roundtable on Science-Policy' in Ottawa, 2004. These quotes come from the rapporteur's published report of the conference and are quotes of statements made by participants or from notes made of discussions or conclusions in conference sessions.

Page	Rapporteur's notes
1	They noted at least three distinct communities at which the science-policy interface is manifest. At the top level are experts, the sorts of people that Ministers like to talk to. On the second level are people with deep and narrow knowledge of a particular issue. Finally, at the broadest level are regulatory scientists, teachers, communicators, and people with second-hand knowledge of the science-based decisions they deal with.
2	Scientist – policymaker relationships: towards science-based policy and policy-oriented science.
2	Science and risk communication
2	Stakeholder involvement in science-based decision-making (e.g., role of PS [public service] versus role of Parliament in citizen engagement).
2	Science, policy, and accountability.
2	Communication at the science-policy interface
2	Citizens and science-based policy: issues around transparency, disclosure, and media.
2	Political leadership on science-policy issues.
2	Communicating science policy decisions (issues).
6	Scientific and policy communities and officials employ different language and have a different culture, which can lead to misunderstandings.
7	Partly the science-policy gap arises because public servants can feel torn between their duty to the public and their duty to their Minister.
8	There is a tension between the desire of scientists to 'instruct' Ministers versus their need to 'serve' Ministers. Ministers on the other hand can feel like they are being 'run' by their scientists rather than being served by them.
8	A lot of the science-policy 'gap' issues relate to the organizational culture of science-based departments.

Again, communication was a main theme along with cultural differences. Policy relevant science and science informed policy was also a key idea; as was political leadership, transparency, and accountability. Watson (2005) also provided a list for making science 'useful' to policy and that list is worth repeating:

- It must be demand driven, and involve experts from all relevant stakeholder groups in the scoping, preparation, peer-review and outreach/communication;
- The process must be open, transparent, representative and legitimate;
- The process should incorporate institutional as well as local and indigenous knowledge whenever appropriate;
- The results and analyses need to be technically accurate;
- The results and analyses need to be policy-relevant but not policy prescriptive – providing options, not recommendations;
- Plausible scenarios of the future should be relevant for policy-formulation over a range of spatial scales from local to regional and global;
- The conclusions must be evidence-based and not value-laden, i.e. they must be devoid of ideological concepts and value systems (however, it should be recognized that the assessment conclusions will be used within a range of value systems);
- It must cover risk assessment, management and communication; and
- It must present different points of view, and whenever possible quantify the uncertainties involved.

The above comments are all attempting to achieve a better rapport between the policy process and scientific research and many of these factors mentioned above are readily apparent in the replies the respondents to my survey gave. Dialogue and understanding between science and policymaking was a major concern and making research more policy relevant and the means to do this was another main theme. However, behind the discourse there is also another factor; that environmental issues facing society are now, or have become, generally more abstract and remote from the general public.
The direct 'effect-impact' has largely disappeared and the problems of environmental degradation are less visible (e.g. ocean acidification), and are more complex long-term problems in a short-term political environment, known as 'wicked problems' (Ludwig et al., 2001).

An insightful paper by Wilcox and Fowler (2001) started to reach deeper into the science-policy gap, introducing what I call 'architectural' elements – an issue I address in Chapter Five. This goes back to Snow's comment about traditional culture resisting change and what Wilcox and Fowler call 'paradigmatic knowledges' in that the two communities have differing perceptions of information relating to a particular issue and its solution. This could also come back to the longstanding mistrust between the two communities as the call for 'science-led policy' has trust for science as an implicit element. Despite this, the authors list a familiar set of causes for the science-policy gap with the suggestion that addressing these may help close the gap:

- Noncommunication. Scientists and policy makers are often unwilling to communicate with one another.
- Ignorance. Policy makers are often completely unaware of scientific research that is relevant to public policy. On the other hand, scientists may be ignorant about how to provide in a form accessible or useful to policy makers for decision making.
- Miscommunication. Failure to communicate the information or ideas intended is a common problem that is exacerbated by the use of different forms of the same national language among scientists and politicians.
- Disrespect. The disrespect for politicians and vice versa is not at all uncommon.

Finally, Alm and Simon (2001) produced an interesting piece of direct research by interviewing 129 scientists spread across a range of disciplines from chemistry to public administration and policy.
They asked four questions about scientific objectivity and scientific advocacy. They found that 'a broad consensus exists across disciplines in favour of advocacy by scientists', and that, 'advocacy is acceptable, individual scientists can be objective and because science can be kept separate from policymaking.
Thus, there is no fear that advocacy by individual scientists will contaminate the objectivity on which all scientists depend.' While advocacy is beyond the realm of this thesis, the ideas about individual objectivity and separation of science and policy, the viewpoint of the individual working scientists interviewed, is somewhat at odds with the primary literature, particularly post-2005.

2.4.2 Political interference

Some of the suggestions made at the conferences are a double-edged sword. The repeated suggestions for 'policy-driven' or 'policy-relevant' science opens the door for the political manipulation of science, as pointed out in a briefing paper from the UK Parliamentary Office of Science and Technology (Anon, 2003):

- Political issues also arise over governments' use of science – for example in justifying predetermined decisions, and underplaying uncertainties.
- Erroneously frame issues as predominantly scientific (e.g. in substituting for moral or value judgements).
- Act as a scapegoat when things go wrong.
- Delay making contentious or complex decisions.

The political use of science, including direct interference, was an equally important area of discussion in this period and the factors mentioned above were prominent. The use of science to inform policy is now ubiquitous, either for operational decisions under management regimes, such as fisheries population assessments for fishing quotas, or used to justify a policy decision. The two overlap and both can be used for political imperatives.

If either of the two become contested there are two main results; one is a codependency between science and policy to maintain the status quo (Rayner, 2002), or the result is what I call 'dueling science'. In 'dueling science' opposing positions argue that the others science is uncertain, poorly researched, or has flawed methodology and conclusions (Sarewitz, 2004) and that their research is the correct 'objective' science (Sarewitz, 1999). Science, especially concerning contentious issues, can suffer from political interference to support the policy favoured by the ideology of the policymakers.

This was a particularly strong issue in the United States at this time. The presidency of G. W. Bush was accused with many instances of alleged or proven direct interference in scientific research results to change results to favour their policy positions. This is the clear and present danger of 'policy-relevant' science, in that if some science is considered 'not policy-relevant' what happens to that science?
The freedom, and necessary independence, of science to draw unbiased and untainted conclusions is considered central to the relationship between science and policy in gaining robust, legitimate and sound science advice (Branscomb, 2004; Wagner, 2001).

Several papers documented a variety of methods of selective science used by policymakers: Censorship of politically sensitive research; suppression of research for a policy agenda; distortion of results to support a predetermined agenda; support, or privileging, of research other workers have concluded is flawed or incorrect, or is not even peer reviewed – but which supports a political agenda; tailoring of individual results to suit an agenda; gagging of scientists from speaking publicly on an issue; privileging one, or a very few, research papers that supports a favoured policy over a wider scientific consensus that contradicts that research; and delaying or simply filing away unwanted research results, to name but a few (Rosenstock and Lee, 2002; McDaniel, 2004; Oreskes, 2004; O'Riordan, 2004; Orr, 2004; Porder, 2004; Union of Concerned Scientists, 2004; Winner, 2004).

Rosenstock and Lee (2002) also detailed how vested interests (here industry) can undermine 'sound science' for their own agenda for policy results. Vested interest manipulation occurs by:

- Industry funding of research to counter scientific opinion (also used by environmental groups, who sponsored research during the IWC whaling debate; see Schweder, 2001);
- Corporate donors often expecting the right to prepublication review of results, leading to the delaying, withholding of results, or the direct or indirect influence on the contents of the results;
- Researchers opinions are also strongly influenced by who funds their research;
- Hired scientists are used for specific rebuttals in scientific journals of research unfavourable to the vested interest (e.g. tobacco research);
- Vested interests also pay for favourable comment in journal articles or editorials.

Delaying tactics are also successful:

- Lawsuits against researchers and research institutions;
- Lawsuits for access to raw data;
- Swamping researchers with administrative tasks and requests;
- Requesting congressional reports, reviews, or inquires;
- Demanding more peer review.

Vested interests also use fake grassroots groups ('astroturfing') to question the science or they affiliate with neutral organizations for credibility. Finally, harassment is possible, such as suing researchers who publish independent research negative to their desired position, threatening research bodies (typically universities) with lawsuits, negative publicity, or withdrawal of funding by the vested interest or an affiliate. These techniques conspire to muddy the waters for policymakers seeking the best 'objective' science and facing conflicting answers. The credibility and motivations of science can suffer, especially if put before the public as part of a campaign to alter public opinion and thus the policymaking process.

Science itself can 'take sides' either deliberately or inadvertently. In 1999, a major survey of endangered lynx populations in the forests of the lower 48 states of the United States began. The next year it was discovered that seven field biologists had been sending unmarked and unauthorized hair samples for analysis. This drew the ire of those opposed to the survey, with claims from private property rights groups and sympathetic politicians of fraud, in that the biologists 'planted' false positives in the survey to support their conservation agenda. The biologists claimed that they were sending in 'blind' (control) samples to test the quality control of the testing lab. This drew the ire of the testing lab, which pointed out that their comprehensive, peer reviewed, and openly published examination protocol contained three separate quality control procedures using blind samples. Whatever occurred will probably never be resolved (Franklin and Burke, 2003).

What happened, however, was that the entire research program was brought into public disrepute, casting doubt on the integrity of government scientific research. Whole sections of the survey data had to be rejected and the case went to Congress, where it was politically used for calls into a review of the Endangered Species Act and the Forestry Service. The spectre of agenda driven science was raised by Pielke, Jr (2004) whose concern was if scientists evaluate their peers research or conclusions from their own political position on an issue, the scientific debate becomes a political one to the detriment of the credibility and validity of science. Finally, Schweder (2001) put forward the argument that competing scientists (either pro- or anti-whaling) had manipulated the uncertainty surrounding whale population estimates in order to advance their differing agendas.

In the EU, Daw and Gray (2005) produced an excellent examination of the failures of the Common Fisheries Policy (CFP). They found that scientific advice usually lost out to political maneuvering.
For example, one report recommended that fishing mortality be reduced by 40% on all fish populations over the 1992-6 period, but the Ministers agreed on a 2% reduction. As Daw and Gray note:

> In the CFP, proposed regulations are watered down most at the stage of the Council of Ministers where national politicians, each answerable to an electorate in their own member states, negotiate and decide to what extent they will accept the proposals of the Commission.
>
> …
>
> As Pirzio-Biroli (Chef de Cabinet to Franz Fischler) put it, 'politicians are always faced with the fishing lobby and there are always elections taking place'. As a result, politics always 'gets in the way' of sustainable fisheries management.

The result is that today there is a:

> … Continuing crisis in the Common Fisheries Policy, where 88% of European stocks are overexploited and 30% in danger of collapse, [which] has led the commission to label its own policy a failure. It has not achieved any of its objectives: to protect stocks, provide a sustainable food source and help fishing communities to be profitable. (Brown, 2011).

2.4.3 Uncertainty

Uncertainty was a topic that returned frequently in this period in relation to policymaking. Earlier, I recognized two main types of uncertainty, operational (called 'functional' in Kinzig et al., 2003) and effect uncertainty. Both overlap and can be used in policy debate, as Schweder (2001) reported. Uncertainty can also be a significant factor in policy inaction (Brown, 2000). However, as Kinzig et al. (2003) point out, 'Politicians already have a well-developed ability to make decisions in the face of uncertainty – they do so every day.' Scientists also understand uncertainty; it is part and parcel of their work. For example Prato (2005), evaluated four methods of establishing uncertainty in species protection decisions: Minimum standard; precautionary principle; minimax regret criterion; and adaptive management. There are other methods, ecology is a difficult science and dealing with uncertainty is a well established process.

Kinzig et al. (2003) proposed that the use of scientific uncertainty in policymaking faced the main problem in that policymakers have differing 'evidentiary standards' when dealing with uncertainty. Given that scientists and policymakers both understand and deal with uncertainty, why has uncertainty often been a prominent stumbling block in policymaking? I have long held that uncertainty is a policy football, used to advance a policy position or to halt change from a current position. Schweder (2001) demonstrates this, but Heazle (2004) definitively put the case thus:

> Put another way, uncertainty only need be a problem when people believe they can achieve their goals by demanding more certainty. … In other words, it is not uncertainty itself that determines or influences policy making so much as how we choose to use it—and that is ultimately determined by political choices about what is or is not desirable.

Sarewitz (2004) continues in this vein:

> I present the idea that uncertainty in environmental controversies is a manifestation of scientific disunity (excess of objectivity; disciplinary diversity) and political conflict.

Uncertainty continues to be mentioned often by working scientists and policymakers, but papers mentioning uncertainty as a topic declined in this period and mainly involved operational uncertainty, or advising that scientists should quantify and explain what the uncertainties in their work mean in a policy context, as the IPCC does now.

2.5 2006-2012

2.5.1 The science-policy gap

Since World War One, science has become an integral part of policy and this is acknowledged by two premier British bodies; the Royal Society (Rees, 2010):

> Public debate and political decisions should be based on the best assessment of the science. And it's the Society's responsibility, as an independent body, to provide such input to governments and, via the media, to the public. … That's why the Society has recently expanded its Policy Centre, so as to enhance its ability to offer authoritative advice. We cherish our independence: advice is offered whether asked for or not.

And the British Ecological Society (Lawton, 2007):

> The British Ecological Society aims to promote the science of ecology through research and to use the findings of such research to educate the public and *influence policy decisions which involve ecological matters.* [His emphasis]

Lawton called for greater involvement of ecologists in debate around ecological issues: 'So there is a role for the BES [British Ecological Society] to argue the ecological corner', as there are, 'many players, different belief- and value-systems, powerful vested interests and so on' but not so many, or so wealthy, on the 'ecological corner'. As well, Schenkel (2010) wrote that, 'Scientists should not be afraid to engage in politics, from local to global'. While Knight et al. (2008) and Fritz (2009) both argued that science must be involved in 'the process of implementation' of policy. These papers indicate a shift in discussion towards a more active, or proactive, engagement by scientists in the policy process. Over this time there was also increasing debate about the role of scientists as advocates (not within the scope of this work, but a good example being Brussard and Tull, 2007).

During this period the discussion continued about the factors involved in the science-policy gap, the main theme being communication between science and policy (Holmes and Clark, 2008; Schaefer and Krantzberg, 2008; van Wyck et al., 2008; Holmes and Lock, 2010; Rudd, 2011) and 'knowledge brokering' (Godfrey et al., 2010). Lawton (2007) listed eleven factors contributing to the gap, all similar to the conferences tabled above and also similar to those listed in Mayer (2006) and Saner (2007). Although Lawton did list a factor not mentioned to date – corruption. This is particularly relevant to fisheries management in developing countries (see Hanich and Tsamenyi, 2009) but occurs elsewhere, for example, speculation about probity in the EU and Mauritanian licensing of the Irish supertrawler *Atlantic Dawn* (Heinberg, 2003; McGuinness, 2006). Burbidge et al. (2011) put forward a capacity building adaptive management approach to the relationship between science advice and policy. While Shanley and López (2009) looked at the specific audiences for scientific knowledge, concluding that the audience for research results should be expanded beyond specialist scientific journals to general publications and science should engage more with stakeholders.

An interesting piece of direct research also appeared, being a survey of scientists and their view of the 'science-policy frontier' (Anderson and Betsill, 2010). While still in preliminary stages, they received 49 survey responses and interviewed twelve scientists. They focused their work on researchers at the Center for Multi-Scale Modeling of Atmospheric Processing (CMMAP) in the US. Their interest was twofold; how do scientists engage with policy and how do scientists see the relationship between science and policy.

They found that the researchers only indirectly engage in the policy process, with 'policy engagement' most commonly confined to researching the impacts of current or proposed policy, that is, producing policy-relevant science. However, the researchers had a high degree of interest in directly interacting with policymakers and being part of making policy (although the latter was rejected by about 20% of respondents) but they actually had low levels of actual participation or interaction.

In an echo of Alm and Simon (2001), they also found that there was a high degree of support for advocacy and scientists being free to publicly 'take sides' on contentious issues. Communication was also an issue for these researchers, and the other suite of factors being similar to those listed by other workers or at the 'Science meets Policy, 2005' conference. Anderson and Betsill defined a policymaker as: '… an elected or appointed government official at the local, state, provincial, national, or international level.'

2.5.2 Political interference

The Union of Concerned Scientists documented 78 cases of alleged political interference from 2002 to 2008 (UCS, 2008), just over one per month. The UCS also released a survey document (UCS, 2006) on political interference within the U.S. Food and Drug Administration (FDA) which reported that:

- Almost one in five (18 percent) responded, "I have been asked, for non-scientific reasons, to inappropriately exclude or alter technical information or my conclusions in an FDA scientific document."
- More than three in five (61 percent) knew of cases in which "Department of Health and Human Services or FDA political appointees have inappropriately injected themselves into FDA determinations or actions."

- Three in five (60 percent) also knew of cases "where commercial interests have inappropriately induced or attempted to induce the reversal, withdrawal or modification of FDA determinations or actions."
- Fifty percent also felt that non-governmental interests (such as advocacy groups) had induced or attempted to induce such changes.

This came from 997 responses to the UCS survey, which found that 62% of the respondents were rated at the 'senior scientist' level with nearly half having worked at the FDA for more than 11 years. In Australia, Diesendorf (2006) discussed the Howard (i.e. conservative, Tory, Republican) government's creation of a secret policy advice group to help form Australian greenhouse gas policy; the group comprised twelve fossil fuel companies. Additionally, the Australian Bureau of Agricultural and Resource Economics formed a secret steering group for greenhouse policy comprised of fossil fuel interests and working within that government bureau.

In the EU, a stated policy objective of ten per cent minimum biofuel use by 2020 was compromised (Sharman and Holmes, 2010):

> We find that the commitment of EU decision-making bodies to internal guidelines on the use of expertise and the precautionary principle was questionable, despite the scientific uncertainty inherent in the biofuels debate. Imperatives located in the political space dominated scientific evidence and led to a process of 'policy-based evidence gathering' to justify the policy choice of a 10% renewable energy/biofuels target.

This is an example of 'selective use of science' (or 'cherry picking'), as recent research showed that:

> Converting rainforests, peatlands, savannas, or grasslands to produce food-based biofuels in Brazil, Southeast Asia, and the United States creates a 'biofuel carbon debt' by releasing 17 to 420 times more CO2 than the annual greenhouse gas (GHG) reductions these biofuels provide by displacing fossil fuels. (Fargione et al., 2008)
>
> …we found that corn-based ethanol, instead of producing a 20% savings, nearly doubles greenhouse emissions over 30 years and increases greenhouse gases for 167 years.' (Searchinger et al., 2008)

In Canada, the collapsing cod fisheries of the Grand Banks were reopened to fishing one month before the 2004 Canadian federal election (Hutchings, 2006). While in the US, the Columbia River salmon hatchery policy was found to be scientifically flawed after censorship by a political appointee who was not a scientist (Lichatowich and Williams, 2009).

In Australia, Polachek (2012) discussed how high-level political interests (here Australia) intervened on behalf of Japan to remove a research article that that revealed large overcatches of the southern bluefin tuna (SBT), an endangered species, by Japanese longliners. The paper was submitted to the Indian Ocean Tuna Commission (IOTC) and the Western and Central Pacific Fishery Commission (WCPFC). Polachek reports that there was no information in the paper that was not already in the public domain of the IOTC and the WCPFC websites but it collated that data into a single paper. Japan requested that Australia withdraw the IOTC paper and the Department of Agriculture, Forests and Fisheries (DAFF) acted.

Without prompting from Japan, DAFF also had the paper withdrawn from the WCPFC when it found the paper had also appeared on their website. The first reason given for withdrawal was that DAFF considered the paper in breach of confidentiality provisions, because it used results presented in a working paper from the Convention for the Conservation of Southern Bluefin Tuna (CCSBT) scientific committee that, in turn, referenced a confidential market review report. The second reason for withdrawal given by DAFF 'was one of political sensitivity with respect to relationships with Japan' (Polachek, 2012).
My suspicion is that it could be related to the continuing Japan – Australia free trade negotiations.

Corruption is a major issue in the Pacific Island States fisheries. Many of these States have low economic growth, political instability, weak governments and institutions, yet have rich fisheries covering thousands of square kilometres of the Pacific in their EEZ (Hanich and Tsamenyi, 2009). The corruption is found in the negotiating of licences and access agreements for distant water fishing fleets and in the monitoring and inspection of fishing vessels. Part of the issue here is that these developing nations must also sign onto a plethora of international agreements such as UNCLOS, the CBD, and CITES. In comparison with richer, developed nations, these nations typically lack the capacity and the funds to carry out their obligations under these instruments (Cochrane and Doulman, 2005). One insightful paper remains to be mentioned. Echoing Rayner's 2004 article, *We know enough*, Cardinale and Svedäng (2008) concluded that:

> Our results strengthen the hypothesis that it is the practise of ignoring the scientific advice more than the advice itself that is to be blamed for the waste of former large marine resources. What we urgently need for securing marine ecosystems is not more data but immediate actions.

2.5.3 Uncertainty

Only two papers in this period are of direct interest. Over the past 30 years, especially since the first marine protected area (MPA) research at Goat Island Bay, New Zealand, MPAs have been proven to be an effective method of rebuilding degraded and over-fished ecosystems if they are implemented properly. Australia has 30% of all MPAs globally (Lenz, 2010) and the use of 'buffer' MPAs as a means of preventing fisheries collapse was explored by Pitchford et al. (2007). They found that under deterministic methods to derive population estimates and set quotas, stochasticity and uncertainty in the estimates can help drive fisheries near to collapse into collapse. An MPA incorporates uncertainty and stochasticity by providing a 'buffer' for the fished population, essentially a 'source-sink' process.

Heazle (2006) examined the development of the precautionary principle (PP) within the IWC. As other workers have shown, uncertainty over population estimates was used, prior to the 1960s, as an argument to maintain maximum catches for the economic benefit of the whalers. Post-1960s, as the market for whale products declined (as well the whale populations) uncertainty was used an argument to reduce quotas as a precautionary action. Heazle critiques the use of the PP within the IWC and notes the vagueness of the PP is leading to stalemate within the IWC; noting, as he did in 2004, that uncertainty and the PP can both be used as political tools to argue for action or inaction:

> Asking "how much precaution is enough?" (or "how much uncertainty is acceptable?") leads us into an epistemological vacuum that encourages policymakers to turn to entirely political solutions to these problems; thereby allowing for a very broad and divergent range of responses, depending on what one's ultimate goals are. The inevitable presence of uncertainty issues, for example, allows criticism of any management procedure or initiative on the grounds of potential risks, which invariably occurs when any of the parties concerned has an interest in opposing a particular policy measure.

2.6 Conclusion

In chapter one, I have traced the relationship between science and policy as well as the science-policy gap. From Nineteenth century scientific triumphalism to post-World War Two science (mainly in the hard sciences) was held in high esteem as a betterment to society and dominance over the natural world and a valuable tool of national defense and superiority – although this latter relationship started to decay with Oppenheimer's famous quotation from the Bhagavad-Gita: 'Now I am become Death, the destroyer of worlds', after he watched the first atomic bomb explode (the *Trinity* test), just a few months before Hiroshima. Generally, science is held in favour when it advances the national interest or would 'tend to increase the Power of Man over Matter, and multiply the Conveniences and Pleasures of Life'.

The developing general public environmental awareness of the 1950s, 1960s, and 1970s along with the maturation of ecological science began to bring science, particularly science relating to human impact on ecosystems and the environment into conflict with Snow's 'traditional culture' – a conflict of purpose, trust, and values. Political interference, as it usually represents the 'traditional culture', has emerged as a major element of the science-policy gap in the last few years. However, a whole suite of issues relating to the science-policy gap have repeatedly reappeared over the last three decades: dialogue (communication); understanding (cultural differences); independence; lack of research; integration; science-led policy; and factors relating to these – policy timeframes vs research timeframes being one example. .

The overwhelming majority of the workers quoted and referenced in this chapter are scientists. Policymakers are rarely represented, or perhaps *pro tem*, by political scientists (however, read my interview (Appendix 1) with *AB*, who recently finished his tenure as a Chief Scientist of an Australian State and who gives insight into the highest level of political decision-making about environmental issues – he is, of course, a scientist).

The approach I have used in these last two chapters, that of relying on the primary literature, has had the benefit of revealing how working scientists and policymakers, who experience the science-policy gap, are conceiving and discussing the science-policy gap, that is, directly from the community involved.

However, when policy and policymaking intervene, and when non-scientists who study policy regard scientists as political actors (or 'political animals') there is conflict. In the next chapters, I show in my research that policymakers rate political interference lower (reflecting, perhaps, more comfort with the needs and priorities of policy) than the scientific community does, and since most of the discourse about the science-policy gap comes from scientists this indicates that science is struggling to make their research conclusions be heard by the culture that Snow (1959) warned us about: 'It is the traditional culture, to an extent remarkably little diminished by the emergence of the scientific one, which manages the western world.' Scientists are trying to 'speak truth to power', but Power is not listening; to quote Cardinale and Svedäng (2008) again:

> Our results strengthen the hypothesis that it is the practise of ignoring the scientific advice more than the advice itself that is to be blamed for the waste of former large marine resources. What we urgently need for securing marine ecosystems is not more data but immediate actions.

The next two chapters examine the current appreciation of the science-policy gap, as experienced by Australian scientists, policymakers, and interest groups. These experiences delineate current boundaries of the gap and cast the gap into relief.

3 Surveying the science-policy gap

3.1 Introduction

The purpose of the postal survey was to learn what people working at the point where science meets policy experience and their views on the gap The survey was under the auspice of the UTas Social Sciences Human Research Ethics Committee, as were the interviews, and both the survey content and delivery and the interview methodology were approved by this committee.

Survey and interview is a powerful tool in researching socio-political issues, especially when coupled with a review of the published literature. In this chapter I explain the mechanics of the survey and interviews to show that they are a competent and valid part of this research thesis. By developing a structure of analysis, I make a definitive typology of factors and elements of the science-policy gap that can be used, or applied, by other researchers examining the science-policy gap.

3.2 The Survey

The postal survey had three components: The respondent pool, design, and survey delivery.

3.2.1 The respondent pool

The respondents of interest in this work are those who work professionally, or are engaged, in research, policymaking, industry, industry representation and environmental representation in Australian marine fisheries and ecosystems – people who practise or observe the relationship of science and policy from the 'inside'. The 'outside' or 'everyman' position was not a consideration for this research as I was seeking people working at the science/policy interface.

I identified four segments in Australian marine science and policy. The first cut separated the respondent pool into science and policy. These stakeholders were: Academics; government scientific researchers; government policymakers. Within these groups I defined university and non-university workers. Academic workers are generally regarded as being more independent and in a position to include more critical analysis and broader commentary in their work, able to speak 'truth to power' with less 'fear or favour'.

The next segment defined the civil society component that participates in the science/policy work for the marine sector. These are environment groups and fishing industry groups, both of which generate, consume, and present marine science and policy of relevance to their interests.

Academics

Academic research workers are intimately involved with marine science and policy by having research interests in these areas and also, in Australia, being called to do research projects for, or in collaboration with, Government and NGOs in marine fisheries science and policy. They are thus in a good position to observe and be involved in the relationship between science and policy. Although some argument could be made to say that this sector could not be considered directly relevant because they are, by the nature of their work, not direct actors in the science–policy interface (which by strict interpretation can only occur at the Government level and only include science and policy workers employed by Government organisations). However, I considered this segment to be relevant as their research product feeds directly into science and policy development so they are informed actors within the science/policy interface.

Government science and policy

These are people who work in primarily non-academic governmental organisations, although these often include a teaching component (mainly by providing for PhD candidates to prosecute their studies). These organisations are involved in focussed science work for industry development and management as well as Government organisations tasked to deliver and maintain the policies managing marine resource use. These workers are key actors in the science-policy gap. The science is generally directly commissioned to inform policy and the scientists become part of the policy process, albeit without (generally) a voice in final policy. These workers are considered to be more constrained in independent voice as they are tied to their employing organisation. For example, there have been controversies in Australia and the USA about climate scientists giving public opinion independently of their employers.

Non-Governmental Organisations

Environmental non-governmental organisations generally work to minimise environmental harm from extractive industries and to maximise environmental protection, while industry groups generally work to accommodate environmental constraints and maximise access and yield for their industries. Both groups engagement in the science–policy gap is active and critical. In a sense they are the 'consumers' of policy decisions by representing the interests of the main affected parties. In this role they in a position to critically appraise the policy-making process, the science, and the decisions. These groups also produce and present policy advice as well as engage in lobbying for particular policy results. Although they are participants in the policy process they are at a remove, however, they are recognised as key stakeholders and so it is worthwhile to include the views of these groups in this work.

Survey respondents were selected by internet and literature search, mainly using the *Current Contents* database. Ambit search terms such as 'marine science au' were used in Google to find Australian organisations with an internet presence. These sites were perused for staff lists and also names of connected organisations that were then specifically searched for. If these organisations did not have an internet presence, I contacted them with a neutral call simply asking if they had any staff working in marine science or policy, noting their names but not making direct contact with these possible respondents.

I avoided surveying or interviewing PhD candidates. These people are doing real research in science or policy and are given places in both university and non-university organisations. Their research is published and is used by the science and policy community. However, I considered that in general they are nascent members of the science/policy community and although they may have insight and opinions their narrow engagement and relatively short involvement in the area precluded inclusion in this research.

Some organisations had no apparent staff lists. In this case I emailed the organisation asking for a list. Some organisations refused, citing Commonwealth privacy law. In this case I had to take a more laborious route. Most organisations of this nature keep publication lists or publication libraries. I then searched through all their publications to an arbitrary cut-off point of five years in the past. I chose this time to maximise the likelihood that the authors were still in the employ of that organisation. I then searched the author's name on *Current Contents* to see their most recent publication. This would tell me if they were still affiliated with an Australian organisation, or if they were a foreign researcher working in collaboration, or if they were an Honours or PhD candidate publishing part of their study. This ensured that the survey was limited to Australian marine workers.

Commonwealth privacy laws were a significant impediment, however, I noticed a rule-of-thumb in that the more politicised the organisation was, the more information controlled they were. For example, the Australian Antarctic Division refused to release any names of staff, but told me that by Commonwealth law they were required to publish details of all research they did, which included the researcher's names. Other organisations had home pages for all their staff, listing research interests and contact details; these organisations tended to be further away from any political centre of gravity. If it was not immediately apparent from the search that the people found were suitable for the survey, I made a literature search to assess their work and decide if they were suitable for inclusion. If I found a person who worked in a marine fisheries research organisation, but discovered that they specialised in designing fish tags or CTD probes and data gathering, I would exclude them from the survey on the basis that their work was not directly in contact with the science-policy gap, as opposed to someone doing research on fisheries biology.

3.2.2 Survey design

The survey was designed as a self completion questionnaire with a return paid envelope. The questions were designed to explore as many aspects informing the science-policy gap as possible on the 'one bite of the apple' principle. There were eight drafts of the questionnaire, with the final two going out to a small focus group of people with experience in survey design and also in the marine science and policy fields. These people were not included in the actual survey, as was anybody I sought advice or information about the survey questions or content.

Given that I expected to be delivering this survey to people who would mainly be post-graduates, particular attention was given to wording, language, font, white space, page structure, and question pacing. The questions were a mix of Likert-type questions, 'yes/no/don't know' responses and written answers.

One question was presented as a continuous variable response. Questions were designed to be as fine-grained as possible, for example the respondent age question was not segmented into age groups but asked for a specific age, only three people declined to give their age. The questions were mixed to prevent 'answer fatigue' and to sustain interest. Questions were also placed to prevent, as much as possible, precognition or respondent 'priming' for the next questions. The questions were designed to elicit an opinion or judgement. There was a final section, external to the survey space, to allow for comments or extra material to be added by the respondents. This was a boxed area to limit verbosity, as were the written response questions within the survey proper.

The questions were made based on my reading of the literature in the area of the science-policy gap, marine science, and policy. The questions were based directly on either papers about the science-policy gap or papers that examine the political, ethical, scientific or philosophical aspects that I read with bearing on the gap or the use of marine living resources. The questions were framed as either statements to which the respondents could agree or disagree with or as questions with a response choice. The questions incorporated some direct quotes. For example, question 9c is a direct quote from a radio interview with an American fisheries manager from the National Marine and Fisheries Service. Question fourteen came from Hanna (2004), and also related to Ziman (1996). Question 16 took part of a comment (bolded in the below quote) by the former Norwegian Prime Minister Gro Harlem Brundtland (Brundtland, 1997):

> I recently came across an article written by a Norwegian scientist during the 1970s, when I was Norway's Minister of the Environment. In the article he argued that there was no such problem as acid rain and that 'facts' and 'science' did not belong in the arena of politics and policy. This assertion was counter to my own beliefs and made me react strongly. Politics that disregard science and knowledge will not stand the test of time. Indeed, **there is no other basis for sound political decisions than the best available scientific evidence**. This is especially true in the fields of resource management and environmental protection.

Questions nine, twelve, and fifteen related to the main themes of the science-policy gap as commonly seen in the primary literature. Question twelve listed the major reasons found in the literature, while questions nine and fifteen detailed finer elements of these major reasons. Question ten queried the respondents perception of different values in managing the oceans. Question eleven was a simple opinion question asking if the respondent considered that the science-policy gap exists in practice.

Five of the most 'political' questions were questions 17, 18 and 22, 23, 24. In Question 17, respondents were asked to judge how research results would be received under four scenarios, while question 18 asked the respondents to rank five factors in order of importance for policy decisions. Questions 22-24 asked about perceptions of bias in scientific research.

All of the above questions were option limited, limiting respondents to responses that I had proposed. Two critical questions were 19 and 20. In these questions respondents were directly asked to propose their own ideas about the causes and solutions of the science-policy gap. In question 19 they were asked about what they thought was the single greatest contributing factor to the science policy gap; and in question 20, how they would change the science and policy relationship. These questions were in a boxed white space giving space for them to express their thoughts but limiting verbosity. The final question, 25, was an ambit question exploring respondent's personal beliefs about the natural world.

Within the questions which had multiple components (lettered 'a' to's', for example), I first made the questions then randomised them to prevent any internal structure or bias. This randomisation was then checked for biasing or conflicting pairings and if this occurred they were randomised again until such leading pairings were removed. To prevent the respondents being influenced by subconscious choice bias when presented by numbered choices all sub-questions were lettered, except Likert type questions.

The survey was presented as an A4 gutter-staple pamphlet to reduce the 'read-ahead' problem and to give a solid document that would be completed in question sequence. It was delivered as a bifold in a C5 envelope to make readability easier, but returned as a trifold in a pre-addressed, post-paid, DL envelope.

This trifold and the return envelope were checked at the printers to ensure that the folded survey did indeed fit into the return envelope, as this is a known failure in survey design. The survey proper was brand neutral, having no logo, letterhead, or organisational identification on any page as this can affect responses and response rate. The letterhead and official identifications was confined to the introductory letter which was enclosed as a separate sheet rather than the front page of the survey, again to make the survey a 'neutral space', uninfluenced by institutional identification.

The introductory letter went through five drafts. It was specifically designed to be a single page for ease of reading and conciseness. The content of the letter was carefully crafted to convey authority, a 'need to complete', and participation. Language was chosen to convey these elements but to retain neutrality and prevent bias or preformed opinion in the respondents. Additionally, the letter carried the university letterhead and was in colour and a different, higher quality, paper stock to convey prestige and authenticity. The letter also contained the official notification of ethical approval, university contacts, as well as researcher status and intent. The name of the lead supervisor and his position within the research framework and institution was also included. The letter included a reproduction of our signatures to personalise and authenticate the letter.

3.2.3 Survey delivery

The survey was delivered only as paper mail. Some organisations that did not release staff lists offered to email staff asking them if they would like to put themselves forward as respondents. Others suggested that I email the survey to their organisation and it would be forwarded electronically to staff for them to complete. These offers were based as measures to comply with privacy laws, yet still willing to try to assist my research. I declined to accept these offers on the basis that it removed control of survey delivery, changed the boundaries of the respondent pool, altered the delivery and thus the response, opened up the possibility that the introductory letter may be ignored, and finally may have let the survey escape electronically 'into the wild' to a potentially large pool of respondents not based in Australia or who were outside the parameters that I made for survey respondents.

The survey was mailed as a complete unit (introductory letter, survey instrument, post-paid return envelope), by a professional printery and mail house. The unit was mailed to all potential respondents at the same time both for ease and to prevent any loss of respondents from having them informed in advance of the survey by colleagues; which may have occurred by using a staged delivery. A second letter was posted to all respondents three weeks later asking them to complete and return the survey if they had not already done so. This letter was a single page set on colour UTas letterhead and signed by my supervisor and myself. This letter only went through three drafts and was sent at a time long enough after the first mailing to allow for delivery time, respondent response and return time, yet early enough so that respondents would remember the survey or had not thrown it away.

3.2.4 Survey analysis

The survey responses were entered as number codes into a Microsoft Excel worksheet, error checks were made every 20 survey forms. This bore dividends when I discovered at the end of data entry that a macro virus had randomly redistributed an unknown number of rows. The data set was then completely re-entered afresh. When the data entry was completed the entire dataset was rechecked, entry by entry, for any errors, seven numbers were found to be erroneous and were corrected. Numerical and graphical information was then produced using the Systat statistical program, although some graphs were produced using Excel. These graphs were used to assess the respondent's replies and to draw out a picture of the science-policy gap.

Questions 19 and 20 required different analysis. These questions were written responses from the respondents containing their ideas rather than a predetermined set of options. The questions were:

Question 19: 'For you, what is the single most important factor causing the science-policy gap?'
Question 20: 'What would you change in the relationship between science and policy?'

The respondent's answers were transcribed verbatim, including spelling errors, etc. These responses were read through several times and then the responses were used to make 'factors' which were then used for coding the responses. By this method, if the first response in question 19 mentioned 'communication problems', that response was made into a factor and coded as 'A' and the next response mentioning communication problems was then coded as 'A'. This sometimes required interpretation of each response and some compression of responses. For example, if a respondent wrote 'communication difficulties' or 'lack of communication', they were also coded as 'A'. This coding proceeded alphabetically and then to Greek letters. This thematic analysis method is a standard tool in this type of research.

Direct quotes were used deliberately in the majority of coding categories to keep the authenticity of the respondents perspectives; e.g. 'Good independent science should be the basis of policy' (Q. 20 , respondent 114, Environment Group), but some were a melding of two terms that individually meant the same but when combined produced a more decisive category wording. A few other coding categories are edited contractions of longer answers, e.g. 'Greater attention being given to the UN as a (reasonably) impartial, scientifically excellent, global, politically neutral source of science/policy (FAO, UNEP, UNDP, WHO, UNESCO etc)' (Q. 20, respondent 50, Academic), became 'Greater attention to the UN as a source of neutral science and policy'. Some of the categories appear only once, as no other respondent mentioned that particular factor, e.g. 'Greater attention to the UN as a source of neutral science and policy'. The resulting keys appear below (Table 3.1 and Table 3.2) and the transcribed responses and their thematic factor codings are in the appendices.

Table 3.1. Q. 19 Factor key.

'For you, what is the single most important factor causing the science-policy gap?'
A - Communication problems.
B - Science not good at delivering answers in policy timeframes.
C - Lack of certainty in scientific results.
D - Political interference.
E - Insufficient science research funding.
F - Lack of understanding by scientists of the policy process.
G - Lack of longer term strategic policy.
H - Policy failure on decision approach to management.
I - Not enough field research that is independent from fishing industry support.
J - Scientific culture of 100% surety before conclusive evidence given.
K - Cultural differences between science and policy fields.
L - Policy-makers not good at asking the right questions of science.
M - Greater accountability needed for decision-makers ignoring the science.
N - Lack of commonsense.
O - Cuts in catch are politically, economically, socially unattractive.
P - Scientists not generally represented in policy-making bodies.
Q - Lack of understanding the role of science in policy-making by policy-makers.
R - Short-term nature of politics.
S - Policy has to incorporate economic, social, cultural and scientific considerations.
T - The kind of advice policy-makers need and what science provides.
U - Scientific results used selectively.
V - Scientists able to give independent results without fear of political retribution.
W - Politics of economics – the power of primary industry to lobby government.
X - Conflict between long-term sustainability and short-term economic needs.
Y - Lack of science education in policy.
Z - Lack of quantitative data (notably in fisheries).
ά - Unwillingness of scientists to promote a particular policy solution.
β - The inability of science and policy to listen to grassroots industry.
γ - Unwillingness to accept the Precautionary Principle.
----- Indeterminate answer, not used.

Table 3.2. Q. 20 factor key.

'What would you change in the relationship between science and policy?'
A - More scientific research with a focus on policy context and policy needs.
B - Greater interaction and integration between scientists and policy-makers.
C - Better communication between science and policy-makers.
D - Embed researchers in policy and *vice versa* for real world experience.
E - Policy needs to have longer term vision and resist short-term politics.
F - A greater understanding by scientists of policy process and requirements.
G - Scientists being prepared to engage in public debate on contentious issues.
H - Policy-makers asking clearer questions.
I - Make decision-makers more accountable.
J - Scientific funding independent and less reliant on industry support.
K – Measurable environmental objectives.
L - Get more scientists into policy-making bodies.
M - Align long-term research and policy strategies.
N - Policy can better accommodate uncertainty.
O - Change timeframes so that policy people stay longer in a role.
P - Minimize political/vested interest interference with science/policy process.
Q- Encourage policy areas to engage staff with scientific credentials.
R - Recruit professional resource managers instead of career public servants.
S - A greater understanding of science by policy-makers.
T - Good independent science should be the basis of policy.
U - Recognize that science advises, it does not set objectives.
V - Involve all stakeholders in decision making.
W - Greater attention to the UN as a source of neutral science and policy.
X - More openness and transparency in the processes.
Y - More scientifically trained politicians.
Z - Integrate more fully the science requirements in policy management.
α - More independence of policy-makers from Government to stop the use of selective science.
β - Agreed environment parameters so that economic value and the environment are protected.
γ - Bring industry and science closer in a more collaborative way for research.
η - Keep scientific advice independent from the influence of policy-makers.
μ - More funding for broader, longer-term, ecosystem/biodiversity research.
π - Remove political and industry representation on research boards.
φ - Be clear about what questions science can answer and what it cannot.
----- Indeterminate answer, not used.

The coded factors were tallied and listed from most frequent to least (see the appendices). Because some of the written responses mentioned more than one factor the coding only extended to the first three factors mentioned and were coded in order of appearance in the response.

The next step in the analysis of questions 19 and 20 was ranking and typing the factors (see appendices). Ranking was simply a matter of giving the most frequent result the ranking of '1' the second most frequent a '2' and so on; factors appearing the same number of times were given the same ranking.

Types were based on what I judged to be linked factors in the context of causes or solutions to the science-policy gap given in the literature. Giving the factors a type brought similar factors into that type, based on the meaning of the type in the broader context of the science-policy gap. In short, this method is a clustered hierarchy; where 'types' are the broader underlying themes of the science-policy gap from the literature and the natural groupings from the questions. The factors cluster below them while the respondents answers cluster below them (Figure 3.1).

For example, in question 19 the factors: 'Cultural differences between science and policy fields'; 'Lack of understanding by scientists of the policy process'; 'Lack of understanding the role of science in policy-making by policy-makers'; 'Scientists not generally represented in policy-making bodies'; 'Science not good at delivering answers in policy timeframes' all come under the type called 'understanding'. The types are shown in Table 3.3.

Table 3.3. Types of causation (Q. 19) or solution (Q. 20) in the science-policy gap, as determined from the survey.

Causation Type	Solution Type
Dialogue	Dialogue
Independence	Independence
Interference	Integration
Policy failure	Interference
Research lacking	Science leads policy
Understanding	Understanding

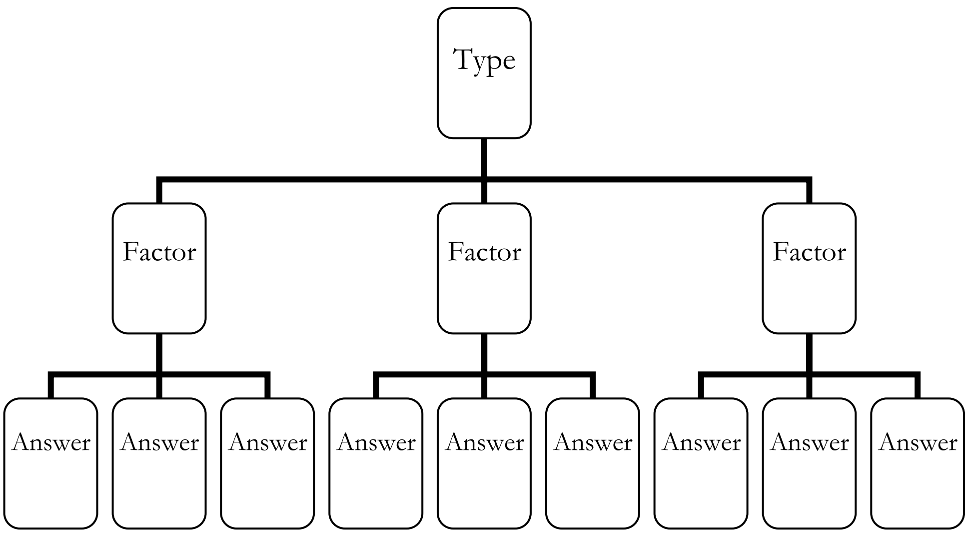

Fig. 3.1 Clustered hierarchy diagram for responses to questions 19 and 20 and the interviews.

3.3 The types

3.3.1 Dialogue

Communication was the most common word used in the written responses, with only five respondents using 'dialogue' (Q. 19; respondent 51 Government policy, 209 Government science; Q. 20 respondent 25 Academic, 76 Government policy, 169 Government science). In the strictest sense of the Oxford English Dictionary (OED), communication is defined as the 'means of sending or receiving information'. More commonly it means, 'the successful conveying or sharing of ideas and feelings' (OED). This does not exactly imply that the material communicated is acted upon or registers with the receiver, information can be simply successfully conveyed; a report can be sent and then subsequently filed unread. I chose to use the word 'dialogue', defined in the OED as, 'a discussion between two or more people or groups, especially one directed towards exploration of a particular subject or resolution of a problem'.

Dialogue is more participatory, more dynamic, one in which information is not only communicated but discussed. This meaning captures more of the variation in, and encompasses more of, the relationship between scientists and policymakers and is slightly different than communication but more precise in describing this aspect of the science/policy interface. Rather than the sending of information, dialogue implies an active role and this came out in the responses:

> 'Improve communication (dialogue!!!) between science and policy'. (Q. 20 respondent 169, Government science)
>
> 'Strengthen the dialogue (formal) between all stakeholders and science'. (Q. 20 respondent 25, Academic)
>
> 'Creation of mechanisms to improve dialogue between scientific community and policy makers…'
> (Q. 20 respondent 76, Government policy)

3.3.2 Understanding

From dialogue comes understanding.

I chose to type one set of factors as 'understanding' to capture a wider variety of interface between science and policy. A common statement used by respondents was 'culture', 'cultural differences' 'cultural barriers'. Culture in this sense means 'the attitudes and behaviour characteristic of a particular social group' (OED). This term is essentially descriptive and in a sense, dismissive. If one says that the science-policy gap is caused by 'cultural differences', it is a closed statement. The important element seen in the factors in Q. 19 and 20 was not just the recognition of culture but the need for understanding:

> 'Understanding the role of science.' (Q. 19 respondent 73, Government policy)
>
> 'The inability of Science and Policy (Politics) to understand and listen to the Grass Roots of Industry.'
> (Q. 19 respondent 6, Industry group)
>
> 'Probably the lack of understanding of the policy process on the part of scientists (including many Soc Sci and humanities disciplines as well as the vast bulk of natural scientists). This is probably more significant than the converse poor understanding of different disciplines by policy agencies and actors.'
> (Q. 19 respondent 84, Academic)
>
> 'The lack of proper communication and understanding of factors which are causing uncertainty. Lack of politicians ability to comprehensively understand uncertainty.' (Q. 19 respondent 22, Government policy)

The factors that fall into the type 'understanding' are those that encompass the need for each culture to understand the other, as well as functional elements that enhance that understanding. This is a fine relationship and some overlap as dialogue moves into understanding and I had to judge when a factor (e.g. Policy-makers asking clearer questions), fell into the different types. Thus this factor, 'Policy-makers asking clearer questions', may at first blush appear to be dialogue, but if one reads into it the factor is about policymakers needing to know, to understand, how to ask questions in terms that science can understand. The reverse makes this clear: 'Communicating results back to policy makers in a way that they can understand' (Q. 20 respondent 74, Government policy). This brings out both dialogue and science understanding how policymakers respond to the language of science.

This factor, 'Embed researchers in policy and vice versa for real world experience', would certainly improve dialogue but I placed it in understanding because of the 'real world experience' which implies more of a cultural immersion than a dialogue. The factor, 'Lack of science education in policy', is again 'understanding' because lack of knowledge implies a lack of understanding. The response; 'The cultural/understanding gap between scientists and policy professionals. They work in different ways, are trained differently and hence do not (in general) understand where the other person is coming from.' (Q. 19 respondent 96, Academic), demonstrates the need for understanding which is defined in the OED as either 'sympathetic awareness or tolerance', 'the ability to understand something; comprehension' and archaically as 'having insight or good judgment'.

3.3.3 Interference

'To interfere is to prevent (a process or activity) from continuing or being carried out properly' (OED). This factor is inherently subjective from the respondent's point of view. However, deciding if a factor fell into the type 'interference' was relatively straightforward. Factors that indicate an outside element, of whatever nature, affecting the science-policy process fell into this category.

Interference factors are generally ones that are external to actors in the science/policy interface.
This generally means interest groups and vested interests, but it also encompasses Government actions or the political agendas of the day. Consider these responses:

> 'Policy makers usually have their own agenda, and will therefore pick and choose what science to base their policy on.' (Q. 19 respondent 222, Government science)
>
> 'Lobby groups with self serving agendas that have no scientific foundation.'
> (Q. 19 respondent 211, Government science)
>
> 'Politics of economics – the power of the primary industry to lobby government.'
> (Q. 19 respondent 98, Government policy)
>
> 'The blatant political manipulation of science and policy to further economic and institutional factors.'
> (Q. 19 respondent 92, Academic)
>
> '…intrusive role of "environmentalists"'. (Q. 19 respondent 193, Academic)
>
> 'Commercial and Industry interests determines politics and policy in this day under current Government. Also, commercial/industry interests are preventing scientists from having a voice'.
> (Q. 19 respondent 100, Environment group)
>
> 'Political influences: no political will to enact good policy – election cycle.'
> (Q. 19 respondent 114, Environment group)
>
> 'Political imperative. Note the number of decisions made just prior to any election. The policy decisions made at the time are invariably what is perceived to be popular to the electorate and rarely has 'scientific validity'. Often it is a 'trade-off' with a special interest group to obtain electoral support or a 'trade-off' for a previously unpopular decision. Witness decisions to favour perceived recreational fishing interests.'
> (Q. 19 respondent 5, Industry group)

Note that all of these responses are different; from the 'intrusive role of environmentalists', to the 'power of primary industry to lobby government' and 'policy makers having their own agenda'. Yet all of these responses point to a collective viewpoint in all the respondent pools; the Industry and Environment groups, Academic, Government science and policy of something different to dialogue and understanding – that of outside influences bending the science and policy relationship; thus the type 'interference'.

3.3.4 Independence

A counterpoint to interference is independence. This type comes from respondents concerns about how science is funded leading to a perceived possibility of control of research agendas and results, and science being able to follow a policy independent research program, as this Government policymaker noted:

> 'To adequately inform policy, science needs to occur before there is a problem. However to do this, science needs to be "crystal ball gazing" to know what will be an issue. This requires a bit of time and resources to allow science to be undertaken without a defined need. The current funding process allows science to only focus on current problems – but given time needed to do a scientific program policy is made without the scientific input. (Q. 19, respondent 35).

Other comments that lead to this type are:

> 'There is not enough on the water and fishery independent research being carried out largely due to cost.' (Q. 19 respondent 26, Government policy)

> 'Essential that one retains independence both through institutional structures and by the scientific community.' (Q. 20 respondent 132, Government science)

> 'Data collection by scientists from log-books, i.e. fisherman information which can be flawed yet is used to determine F_{msy} of a species or scientific "precautionary principle" advice…'
> (Q. 19 respondent 4, Industry group)

> 'The lack of available funding to address the critical questions identified by policy makers independently of political agendas.'
> (Q. 19 respondent 161, Academic)

3.3.5 Integration

'The action or process of integrating: economic and political integration.' (OED)

Integration as a type came from respondent's comments directing science and policy to be more interconnected. This direction appears essentially at odds with independence, yet it was a clear imperative by the respondents and the differences between the two are subtle. Examples are:

> 'Stronger linking between policy objective setting and allocation of funds to meet policy management decision making for science.' (Q. 20 respondent 92, Government policy)

> 'Closer links – especially in formulating research directions and priorities.'
> (Q. 20 respondent 31, Government policy)

> 'Get more scientists into policy making bodies.' (Q. 20 respondent 59, Government policy)
> 'Create cross-institutional or cross-cultural organisations including the best scientists and policy makers (not mid-level to bureaucrats) to come up with a joint approach to conducting scientific research to inform the policy process.' (Q. 20 respondent 187, Government science)

> 'Make it clearer at the outset of a policy development what weight is to be attached to the science <u>before</u> the results come in.' (Q. 20 respondent 85, Academic)

3.3.6 Policy failure
This type derives from respondents who answered that policy can sometimes fail because it is not correctly designed or implemented, not necessarily by any intent (which would be 'interference') but by lack of foresight or purpose, and especially lacking long-term objectives.

> 'Lack of longer term strategic policy, within which short term decisions (and research), are needing to fit.' (Q. 19 respondent 41, Government policy)
>
> 'Clear policy objectives.' (Q. 19 respondent 168, Government science)
>
> '… Where the decision-making process is poorly defined and not transparent and the exact role of science is poorly enunciated the gap will remain.' (Q. 19 respondent 2, Industry group)
>
> 'The lack of clear policy objectives and associated decision rules.' (Q. 19 respondent 172, Academic)

3.3.7 Research lacking
This type exists because of the contribution by one of the interviewees (*IJ*) who said,

> 'One [reason] is that the science doesn't exist; in other words there's no science that can help fill a policy, that it can inform policy or help fill a policy gap. Or there's plenty of science there, but it's not in a form that's accessible to policymakers. So there's two, two holes in that direction; one is the existence or otherwise of relevant science, and the other one is the existence or otherwise in science that's in a form that's understandable by policymakers.'

3.3.8 Science leads policy
This type comes from respondents and interviewees who commented along the lines of Gro Haarlem Brundtland; 'There is no other basis for sound political decisions than the best available scientific evidence.' This approach was clearly seen in the answers, examples being:

> 'Scientific evidence needs to be given greater prominence, and needs to be accepted as the dominant filter (ie given priority) in decision-making' (Q. 20 respondent 151, Government science)
>
> 'Make science the basis of policy decisions (rather than economic).' (Q. 20 respondent 186, Government science)
>
> 'Stronger guidance of policy by science and the precautionary principle.' (Q. 20 respondent 103, Environment group)
>
> 'Policy makers should base their decisions on science.' (Q. 20 respondent 152, Academic)

3.4 Statistical analysis of the survey
Other than the demographic section, the survey questions were of four types: Ranking (Questions 8, 10, 12, 14, and 18); Likert scale (Questions 9, 11, 13, 14, 15, 21, 22, 23, 24, and 25.); yes/no/don't know (Questions 16 and 17); and written reply (Questions 19 and 20).

Likert-type questions were predominant and the question is then how to analyse them. This is not a trivial question and debate about the appropriate statistical method for Likert-type questions has simmered since the 1940s (e.g. Lord, 1946). The debate has centred about measurement (interval or ordinal scale) and method (parametric or non-parametric), and the interpretation thereof. Hand's (1996) review of measurement goes to representational measurement theory (p. 449), operational measurement theory (p. 453), and finally to meaningfulness (p. 461). As he writes, 'This is worth emphasizing: the reason that distribution-free methods are appropriate for ordinal data whereas 'parametric methods' typically are not is that the former tests hypotheses which can be meaningfully stated for ordinal data (are invariant to permissible transformations) whereas the latter do not. The issue is whether or not the hypotheses being tested are meaningful.' Thus a key issue in Likert scales is type of data the answers represent.

For the analysis of Likert scales the debate has centred about ordinal or interval data. One side of the debate follows Lord's comment: '"The numbers don't know that," said the Statistician. "Since the numbers don't remember where they come from, they always behave the same way, regardless"'. This is essentially an operational approach.

However, Stine's 1989 paper on meaningful inference concludes that, 'The measurement context within which statistics are calculated is of the utmost importance. Performing sophisticated analyses that are appropriate for one scale of measurement (e.g. interval) on data that reflect a less structured scale (e.g. ordinal) yields nonsense.' As he writes *en riposte* to Lord, '"I'm interested not in the numbers, *per se*, but in what they represent," asserts the Professor wryly. "So let me see if I've got this straight. A quarterback times a lineman gives me a fullback?"'

The important element here is what the numbers represent within a Likert scale. This scale assesses attitude, belief, or opinion in the context of a hypothesized latent variable. The response categories ('strongly agree', etc.), are approximations of the respondents attitude and the scale numbers applied to the descriptive response categories are not interval measures (what is halfway between 'agree' and 'strongly agree'?), so I consider that the scale is ordinal in nature (Clason and Dormody, 1985).

The structure of the Likert scale (with the null response being central) is conducive to non-normality (Nanna and Sawilowsky, 1998), which damages one of the fundamental assumptions of parametric tests. Nanna and Sawilowsky compared the parametric *t*-test against the non-parametric Wilcoxon rank-sum test using real (rather than simulated) Likert scale results and found that the Wilcoxon rank-sum was more robust and more powerful than the *t*-test. If any statistical analysis is required for Likert scale survey questions I will rely upon ordinal data tests, like the chi-square, Wilcoxon rank-sum, or Spearman's Rho.

3.5 The interviews

3.5.1 Interview method

A note in the survey instrument asked people who were interested to self-nominate for an interview. Seven people did so, however, I decided to not interview these people as their perspective may be altered by completing the survey. The interviewees were selected on a purposive sampling based on their position or experience in the area of science and policy. The interviewees were selected to balance between science, policy, and NGOs. Interviews were designed to be no more than fifteen minutes with eight questions, with a final period allowed for additional comment. I directly contacted these high-level executives as, mentioned earlier, sending a request via email may well be screened out by their personal secretaries. Luckily, all the interviewees contacted were keen to participate as the science-policy gap, while not having a high public profile, is an issue that is vexing to people involved in managing marine living resources.

The interviews were conducted as semi-structured interviews so the questions were not asked one after another but during a 'conversation' with the interviewee. Questions were introduced to complement the direction the conversation took thus making them able to be extracted for analysis form the conversation while retaining their contextual validity. Comments or remarks made during the conversation but outside the bounds of the questions were not used except if they were such a quality that they could be used separately from the questions. All interviews but one was done by recorded telephone calls with interviewees contacted at their convenience and in no particular order. Interviews were transcribed verbatim. The questions were based on the literature and survey results and were more directed at the causes of the science-policy gap, given the limited time of interview.

The questions that were asked were:
- How do you define the science-policy gap?
- For you, what is the main cause of the science-policy gap?
- How do you see the science-policy gap operating in practise?
- Which real world situation can you give as an example?
- What main social-political tensions do you think are behind the science-policy gap?
- How do the decision-makers fit into the play between science, policy-makers, and the science-policy gap?
- What is the dominant culture in marine resource management and how does that affect the science-policy gap?

Some of these questions were covered in conversation so were not directly asked. From the transcribed interviews (Appendix 1) specific responses that addressed these questions were collated and used to type the interviewee's assessment of the science-policy gap along the same lines as the survey responses were developed as factors and types.

3.6 Conclusion

The research approached described in this chapter is a standard methodology for researching the types of questions posed by this thesis. I have briefly described the development of the survey to show that it is a comprehensive and crafted research instrument. The interviews flow naturally from this survey and focus on an expert subset of the pool of respondents. These two approaches, coupled sith an extensive review of the literature, provide a solid basis for analysis and conclusions. The next chapter introduces the results, with a particular focus on the strongest signals found in the survey data and in echoed in the interviews.

4 Measuring the science-policy gap: the survey and interview results

4.1 Demographics and survey balance

I sent out 671 surveys to the five groups (science, policy, academic, industry, and environment groups) the return was 235 surveys with eight returned as 'addressee unknown', which gives a return rate of 35.4%. The mean age of respondents was 43 years and ten months. The educational background of respondents was 76.1% university postgraduate; 9.4% university honours degree; and 8.6% university undergraduate degree; and the rest were school leavers. The mean work life of the totalled groups was 14 years and 8 months, meaning that most of the respondents had been working in their sectors long enough to have an understanding of the issues.

The current work sector of the respondents was (rounded to whole numbers):

- Government policy: 29%
- Government science: 28%
- Academic: 31%
- Environment group: 6%
- Industry group: 7%

This indicates that the respondent return was well balanced; with Government science, Government policy, and academics almost equally represented. Responses from the two interest groups were also almost equally represented. This means that comparison between the sectors is valid as there is no large disparity requiring weighting methods, etc. I made no comparisons between interest groups and science, policy, and academic; as the latter are within process with the former external players in the policy process.

In the following graphs the words 'government' and 'environment' are contracted to 'govt' and enviro' as the program used to generate the graphs (Systat) had a label character field limitation of 16 characters. It was not possible to use the full words. Additionally in the following results some percentage data do not add to 100% in total owing to rounding down to one significant decimal place. Finally, in all graphs, the question axis is labelled by alphabetical sub-question/question number, e.g. Question 17, sub-question D is labelled D17.

4.2 Survey results

In response to this question: 'Do you think there is a gap between the scientific advice that is given and the final policy decision?' the overall responses were:

- Often: 54.1%
- Sometimes: 44%
- Rarely: 1.3%
- Never: 0.4%

The individual work sector results are in the appendices, while the percentages above do not round to 100 (total: 99.8) owing to rounding to one significant decimal place. The 0.4% 'never' response came entirely from the industry group; overall 98.1% of respondents considered that there is a gap 'often' and 'sometimes'. Like information theory, much of ecology is trying to 'find the signal in the noise'. In the context of this research, if 98.1% of respondents believe there is a gap, what is the 'signal in the noise' according to them?

In question 12, I asked: 'From the following terms, please choose six (6) that you consider to be the main reasons for the science-policy gap, ranking them: 1 = main reason; 6 = least reason.'

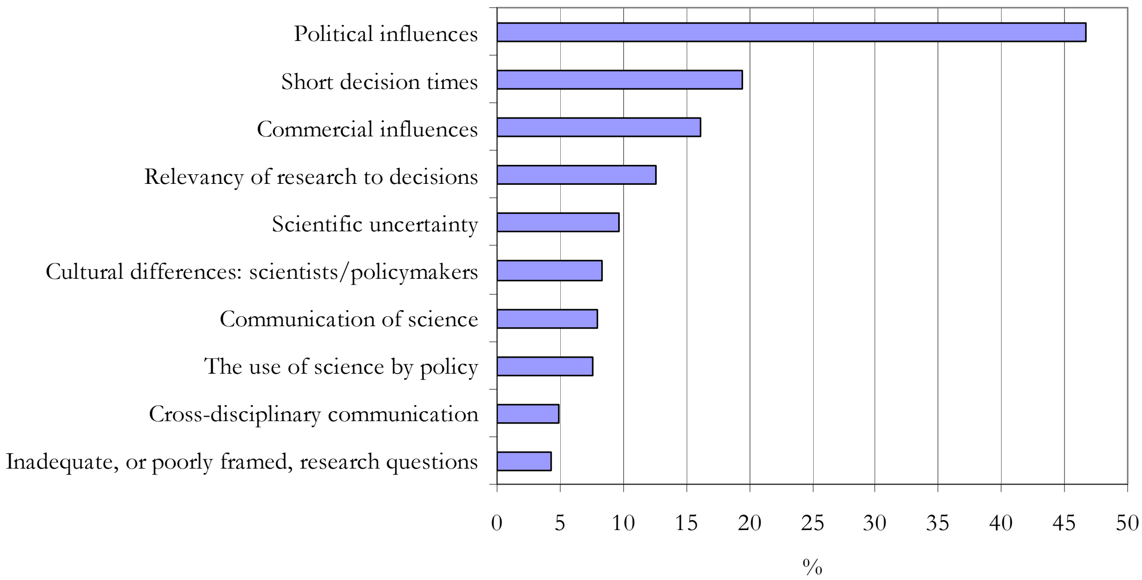

Fig. 4.1 The percentage of respondents ranking the factors in Q. 12 as the main reason for the science-policy gap.

One can see that scientific uncertainty is ranked fifth. The largest factor was 'political influences' which featured strongly in all sectors (see the appendices). If the analysis is broadened to group which factors were in the 'top three' choices of reasons, one gets the below result:

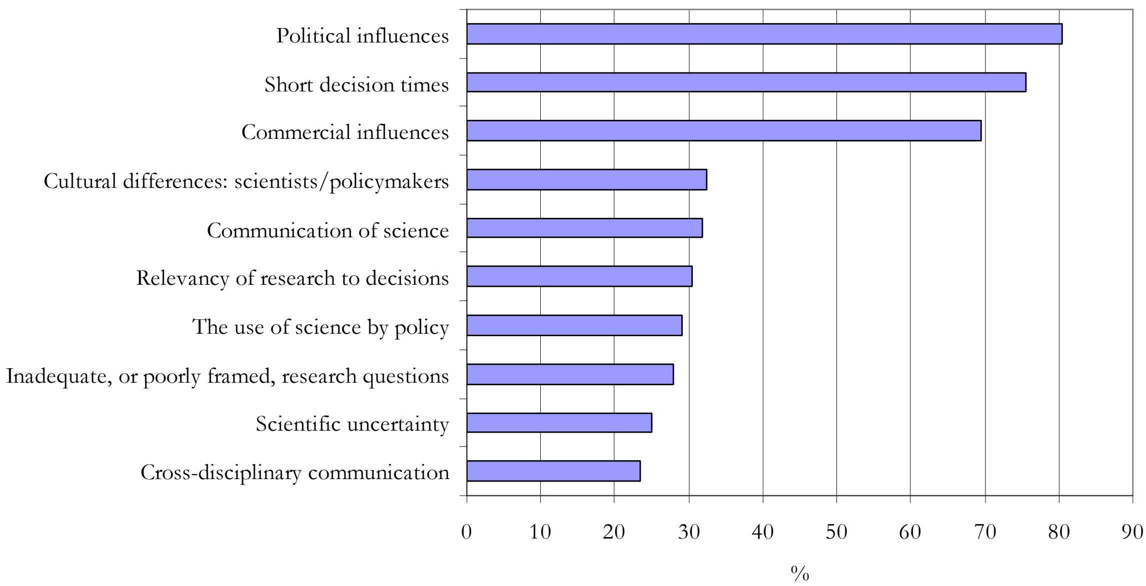

Fig. 4.2 The percentage of respondents ranking the Q.12 factors in the 'top three' reasons for the science-policy gap.

Note that scientific uncertainty drops to second last position but the factors that respondents put in their first three choices remain the same as in the first choice graph (above): being political influence; short decision times; and commercial influences.

The graphs below show questions that were, as mentioned in Chapter Three, randomly assigned in the survey but are drawn out here. The questions are either very similar in wording and meaning or represent alternate viewpoints. The results are interesting in that they show quite strong responses from all groups, or responses that separate the scientific community from the policy community. For example, in graph I9 (Fig. 24), the scientific, academic, industry and environmental groups are in general agreement with the statement, 'policymakers frequently discount scientific advice'; yet almost as many policymakers agree as disagree. But in answer A15, policymakers overwhelming consider themselves receptive to research results, indicating a disconnect between perspectives on information and action. The following results explicitly show the respondents views on the use of science by policy.

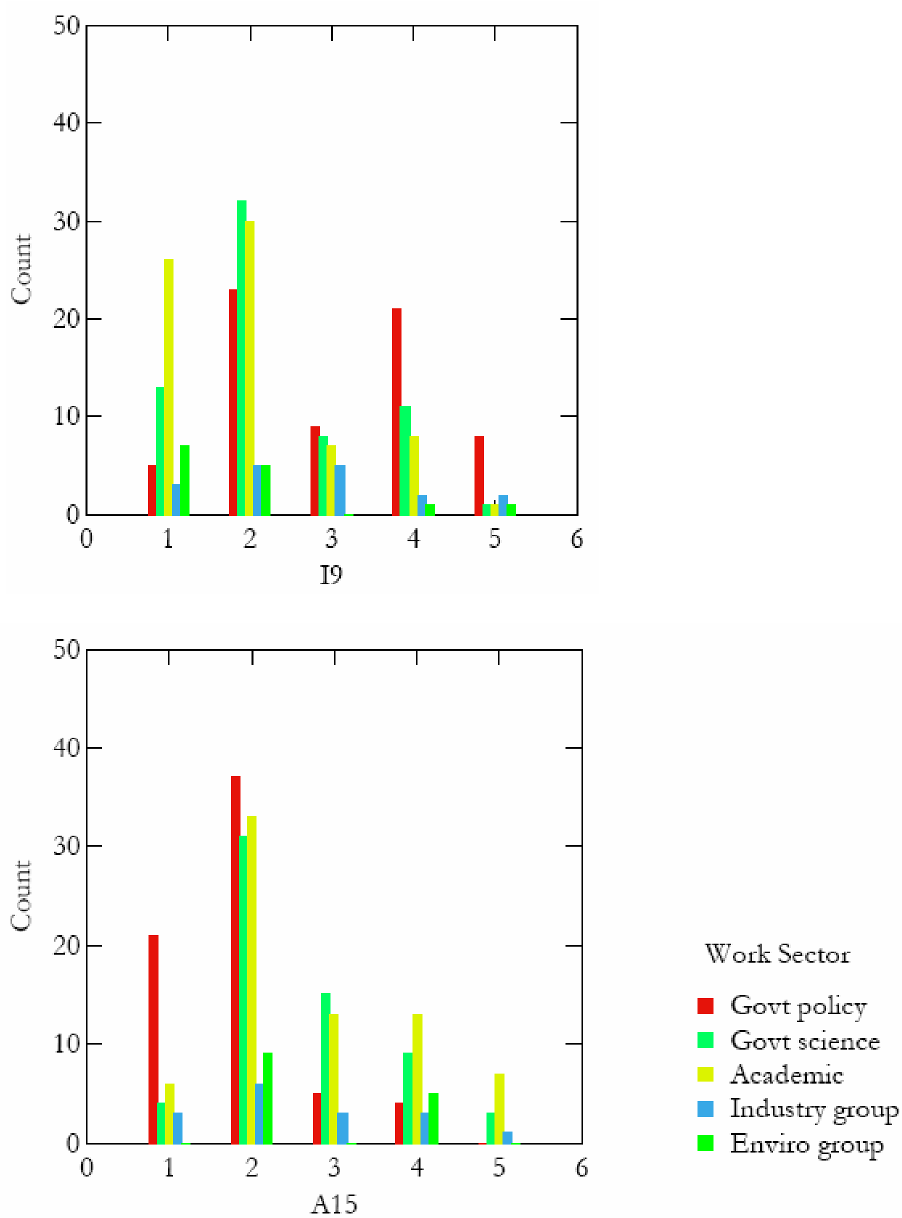

Fig. 4.3 Survey responses for the following statements, measured by respondents level of agreement.
'Policymakers frequently discount scientific advice' (I9);
'Policymakers are receptive to research results' (A15).
(1–strongly agree; 2–moderately agree; 3–neutral; 4–moderately disagree; 5–strongly disagree)

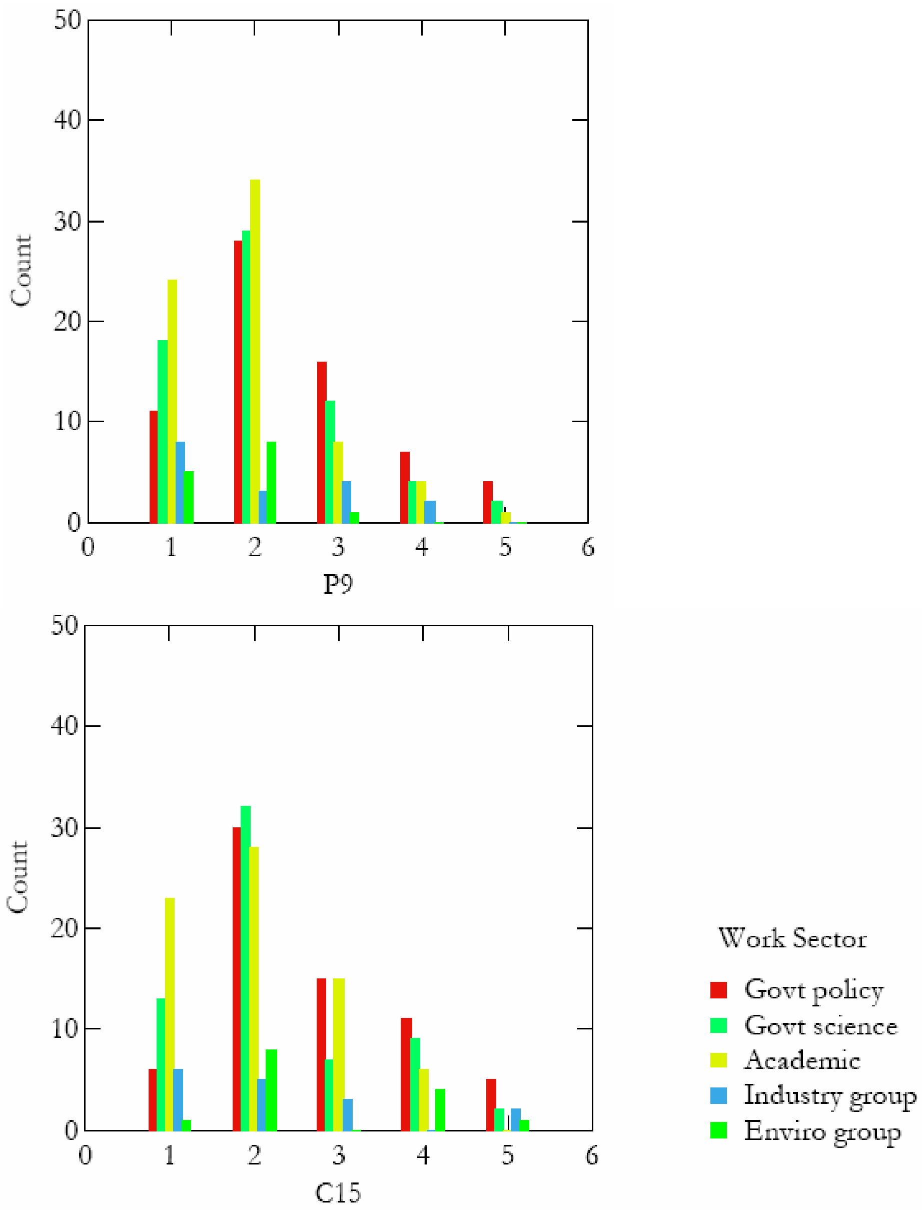

Fig. 4.4 Survey responses for the following statements, measured by respondents level of agreement. 'Scientific research results are selectively interpreted for political use' (P9);
'Policymakers select research that supports their policy goals' (C15).
(1–strongly agree; 2–moderately agree; 3–neutral; 4–moderately disagree; 5–strongly disagree)

Here again is the disconnect; in A15 the majority saw policy as 'receptive' to research but the majority of the respondent groups in the above are clearly of the opinion that the science is then used selectively used to support policy or political intent.

In the EU, Daw and Gray (2005) clearly drew this conclusion in terms of manoeuvres within the Common Fisheries Policy, but it is surprising to see it so clearly within a community of science and policymakers mainly concerned with Australian fisheries, which are seen as well, and sustainably, managed.

The next results are just as clear: Science is not independent from policy.

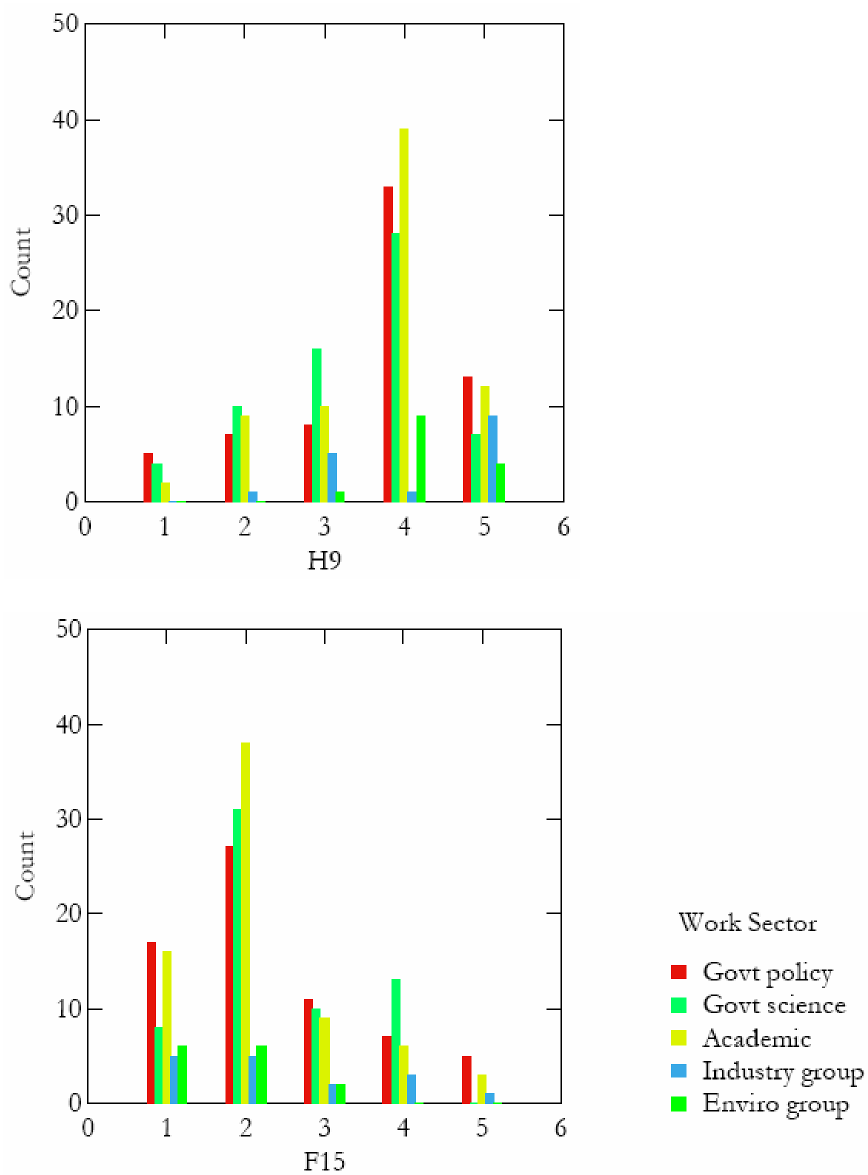

Fig. 4.5 Survey responses for the following statements, measured by respondents level of agreement.
'Scientific advice is always independent of policy purposes' (H9);
'Scientific research is not independent of political institutions' (F15).
(1–strongly agree; 2–moderately agree; 3–neutral; 4–moderately disagree; 5–strongly disagree)

Much of the science is done, quite naturally, for management policy and assessment in fisheries. Indeed, as seen in the written responses to Q. 19 and 20 (below) and in the literature (e.g. Tables 3.1 – 3.4), there is much desire to reduce the gap by integrating science and policy; so that policy asks the 'right questions' and science gives the 'right answers'. However, there are two main issues that rise from these questions. The first is that, as in Fig 4.4 (above), science is seen to be used selectively to support an agenda and for Wagner (2001), Anon (2003), and other workers this leads to concerns about how 'independent' agency research is from political needs or manipulation. 'Policy driven' or 'policy relevant' science is a double-edged sword. The second is that as noted in the survey written responses, by the Royal Society (Rees, 2010), and the British Ecological Society (Lawton, 2007), integrating science into the policy agenda leaves little room for independent assessments, or even independent research (or 'curiosity' or 'blue sky' research). These may be reasons for the more diffuse response to the below question (Fig. 4.6).

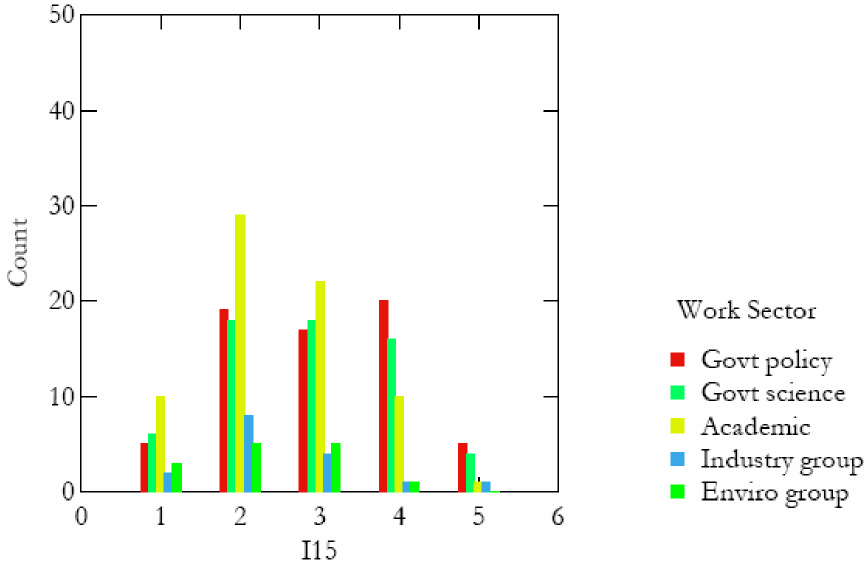

Fig. 4.6 Survey responses for the following statements, measured by respondents level of agreement. 'Research designed to answer a policy question is often politically biased' (I15). (1–strongly agree; 2–moderately agree; 3–neutral; 4–moderately disagree; 5–strongly disagree)

Here there is more ambivalence in response, note the proportion of responses that chose 'neutral'. The greatest response in the affirmative was from the academic community and the interest groups. I draw these responses further in the results for questions 22 – 24. As we can see from these graphs, there is general agreement that scientific research is not independent of policy purposes, and that research is selectively used for policy purposes. Policymakers gave a strong affirmative response that they perceived themselves to be receptive to scientific research, which was backed up by scientists and academics, the majority of whom 'moderately agreed'. The real, or perceived, lack of independence is problematic as is the selective use of research. The converse to 'policy driven' research and its problems is 'science-led' or 'science-driven' policy. This has been a debated point within the primary literature and I asked a binary question, 'yes or no' to Brundtland's (1997) statement: 'There is no other basis for sound political decisions than the best available scientific evidence.'

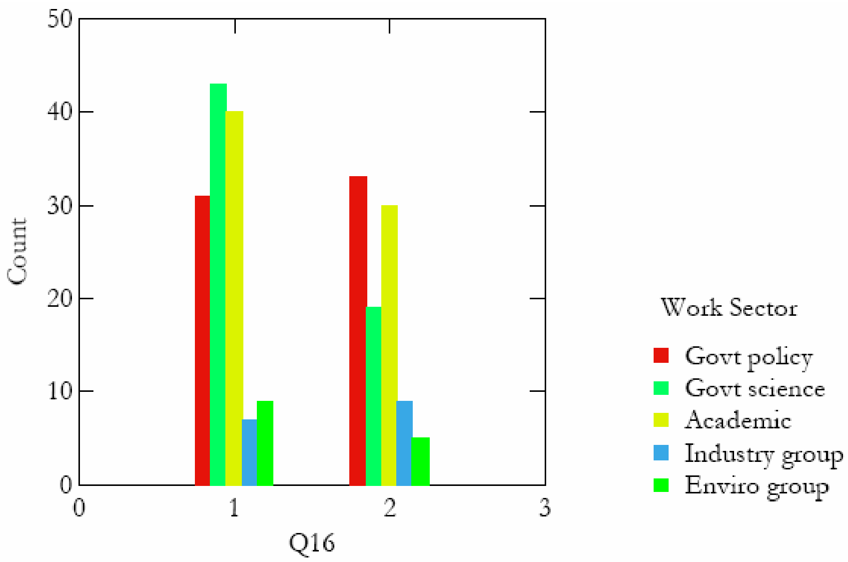

Fig. 4.7 'There is no other basis for sound political decisions than the best available scientific evidence.' (1 = Yes; 2 = No).

The pooled results showed clear 'yes' results: 57.2%-Yes; 42.5%-No. An almost equal number of government policy workers answered yes and no, which may indicate a tension within that community.

The clear preference for 'yes' is seen in government science, academics, and environmental respondents, perhaps indicating more acceptance of this viewpoint; while slightly more industry groups respondents said no, again perhaps because of their economic perspective. Interestingly, when three ranking type questions that were similar to the Brundtland quote were asked, the results also showed a preference for science based policy, as shown below.

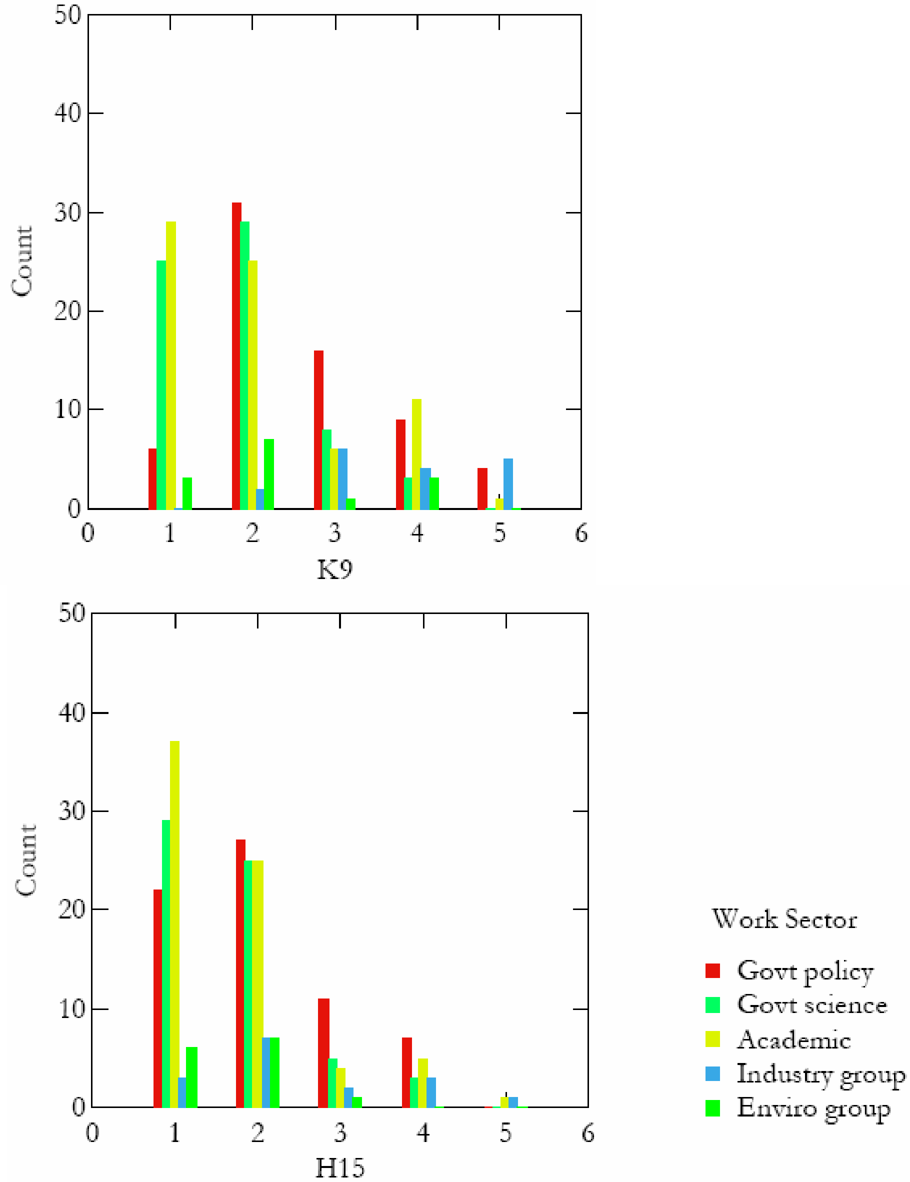

Fig. 4.8 Survey responses for the following statements, measured by respondents level of agreement. 'Science should shape marine policy' (K9). 'Policy should be science-based' (H15). (1–strongly agree; 2–moderately agree; 3–neutral; 4–moderately disagree; 5–strongly disagree)

The less strong statement, 'policy should be advised by science' (below), received the clearest positive response. As well, 'advised' is more neutral than the stronger Brundtland statement. Still the signal is strong: Science should advise policy; policy should be science-based; and science should 'shape' policymaking decisions. Policy selectively uses or ignores research; policy-led research is not independent.

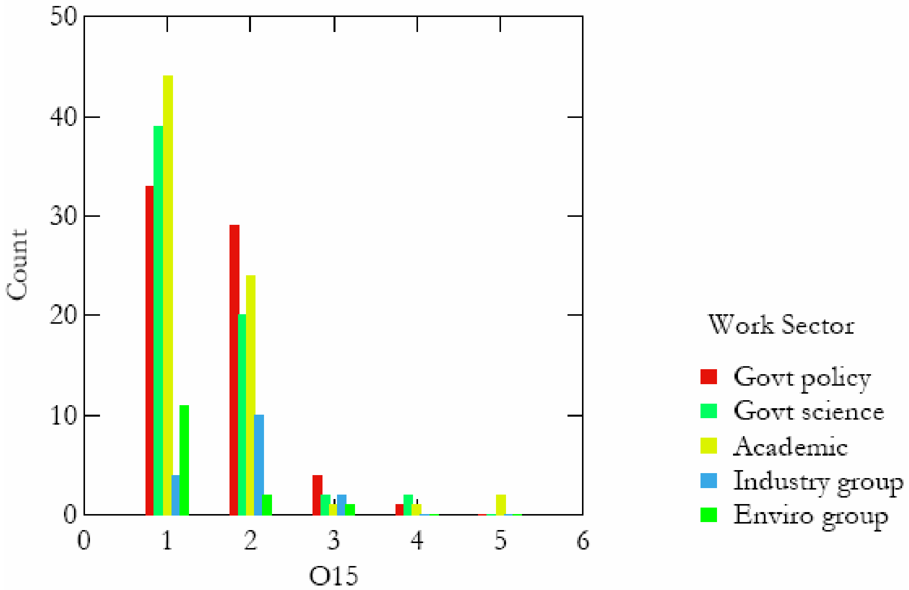

Fig. 4.9 Survey responses for the following statements, measured by respondents level of agreement.
'Policy should be advised by science' (O15).
(1–strongly agree; 2–moderately agree; 3–neutral; 4–moderately disagree; 5–strongly disagree)

If there is a strong agreement about the need for science-based and science-advised policy another thing of interest is how the respondents saw bias or non-independence from policy in the scientific literature (as asked in Q. 22 – 24). However, a more immediate interest is when science research is ignored or accepted.

A major theme in the literature, from the very beginning, is the use of science by policymakers and how interference affects the use of science by policy. The respondents shared this concern, ranking political interference and economic influences as first and third, respectively.

As Daw and Gray (2005) noted:

> In the CFP, proposed regulations are watered down most at the stage of the Council of Ministers where national politicians, each answerable to an electorate in their own member states, negotiate and decide to what extent they will accept the proposals of the Commission.
> …
> As Pirzio-Biroli (Chef de Cabinet to Franz Fischler) put it, 'politicians are always faced with the fishing lobby and there are always elections taking place'. As a result, politics always 'gets in the way' of sustainable fisheries management.

In a similar vein international politics and trade act as Polachek (2012) has showed in the request from Japan that Australia withdraw certain research results that revealed Japanese over catches of southern bluefin tuna. The reasons being given as commercial sensitivity and 'of political sensitivity with respect to relationships with Japan'.

In broad terms the concern is the prioritisation of economic interests over scientific advice, and the precedence these economic interests are given by policy. As interviewee CD (a senior policy adviser) said:

> Well each level of the policymaker will have different constituents, *but at the top level, you know, the policymakers want to basically, on the whole, they want to look after the fishing industry and ah, and so on,* [my emphasis].

To explore these influences I asked in question 17:
'When are scientific research results likely to be ignored, dismissed or marginalised?'
The categories are: 1 = Yes, MOST likely to be ignored; 2 = No, LEAST likely to be ignored.

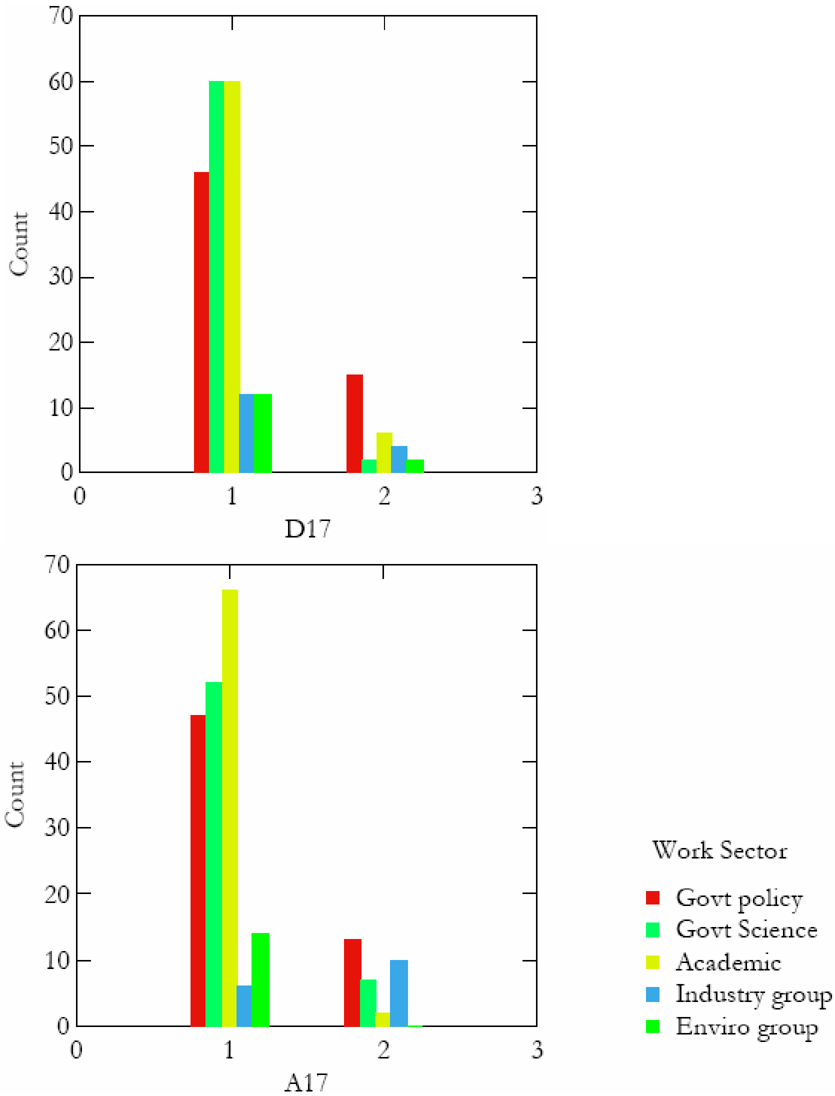

Fig. 4.10 Responses to Question 17, 'When are scientific research results likely to be ignored, dismissed or marginalised?' 'If they do not support a political agenda' (D17). 'If they do not support economic interests' (A17). (1 = Yes, 2 = No)

If we turn these data into pooled percentages the responses very clearly show the respondents beliefs:

If the scientific results do not support a political agenda the number of respondents believed:

86.8% believed the results would be most likely to be ignored, dismissed or marginalised.
13.2% believed the results would be least likely to be ignored, dismissed or marginalised.

If the scientific results do not support an economic agenda the number of respondents believed:

85.3% believed the results would be most likely to be ignored, dismissed or marginalised.
14.7% believed the results would be least likely to be ignored, dismissed or marginalised.

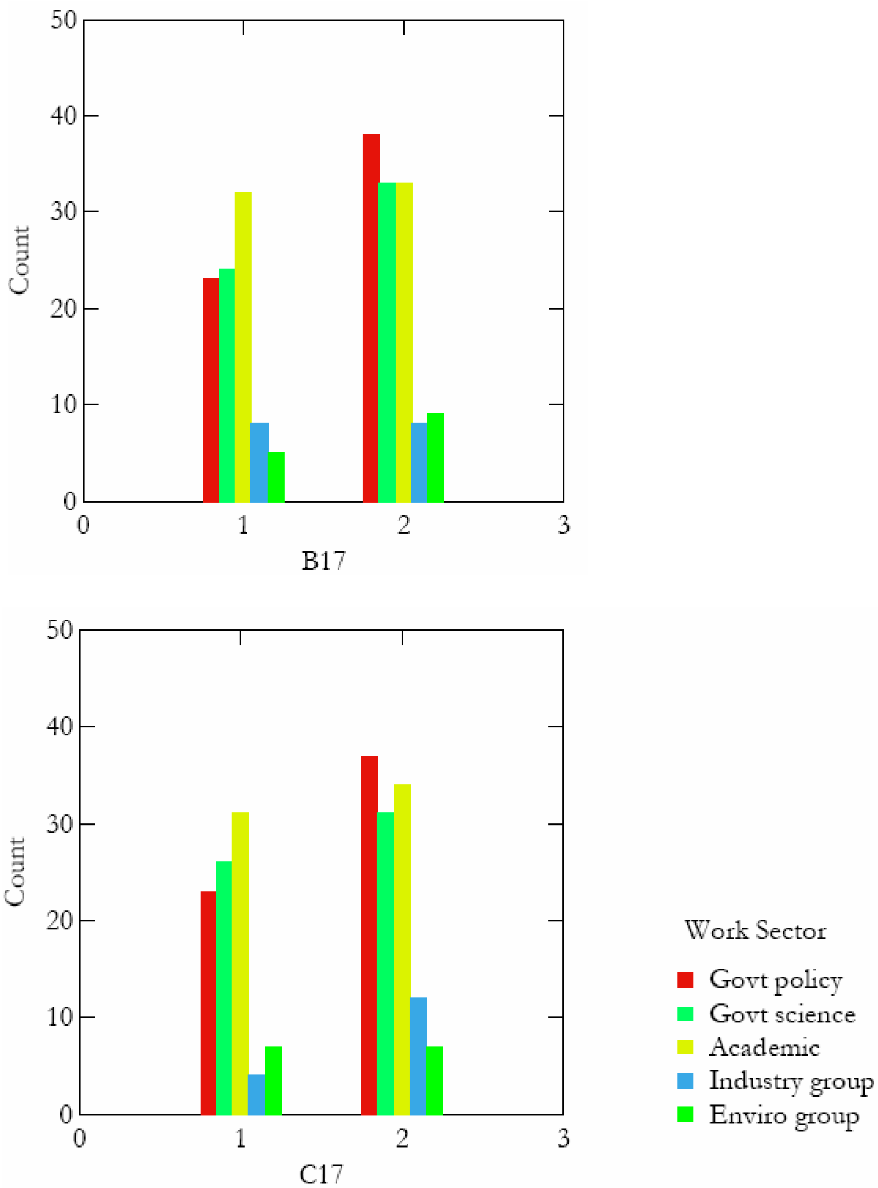

Fig. 4.11 Responses to Question 17, 'When are scientific research results likely to be ignored, dismissed or marginalised?' 'An economic loss will occur' (B17). 'An environmental loss will occur' (C17). (1 = Yes; 2 = No)

If we turn these data into pooled percentages the responses are similar but show in these cases that the stronger belief lies towards 'least likely', which may seem odd but the first questions went to 'agenda' and these responses go towards 'action'.

If the scientific results indicate an economic loss will occur if the results are not accepted:
    43.2% believed the results would be most likely to be ignored, dismissed or marginalised.
    56.8% believed the results would be least likely to be ignored, dismissed or marginalised.

If the scientific results indicate an environmental loss will occur if the results are not accepted:
    42.9% believed the results would be most likely to be ignored, dismissed or marginalised.
    57.1% believed the results would be least likely to be ignored, dismissed or marginalised.

The first two percentages are almost identical to the latter two, and from the figures it is apparent that the work sector choices are reasonably consistent across the questions, indicating that these beliefs are consistently held across the work sectors. It is interesting to note that there was strong belief that scientific advice is most likely to be ignored if it did not support political or economic interests. I then asked in question 13 a similar set of questions but in yes/no/don't know, unranked form and these were the results:

Does the market economy create problems in making policy?
Yes: 80.2%
No: 14.2%
Don't know: 5.6%

Do short-term policy goals create problems in making policy?
Yes: 88.9%
No: 7.7%
Don't know: 3.5%

Does scientific uncertainty create problems in making policy?
Yes: 83.5%
No: 11.7%
Don't know: 4.8%

Does the scientific method create problems for making policy?
Yes: 33.2%
No: 50%
Don't know: 16.8%

Do cause and effect relationships create problems in making policy?
Yes: 55.2%
No: 27.8%
Don't know: 17%

While the top three reasons for the main cause of the science-policy gap (question 12, above) placed uncertainty near to the bottom of the list, here 83.5% responded that scientific uncertainty makes problems for policymaking. This indicates that uncertainty is probably experienced more as a practical issue in making policy and a lesser issue as a causal factor in the gap. This fit with Schweder (2001), Kinzig et al. (2003) and Heazle (2006) who argue that the role of uncertainty in the science-policy gap is more as a political tool in the negotiation of decisions. The response to 'scientific method creates problems' had the strongest 'no' response from the groups, although Government policy workers gave the highest 'yes' response from those that answered 'yes'. This could indicate the 'two cultures' lack of understanding.

I next broadened the question to general societal forces that could influence the science-policy gap. In question 18, I asked, 'Please rank how important the following factors are in determining policy decisions.' The factors were: Economic; Institutional; Political; Social; Cultural.

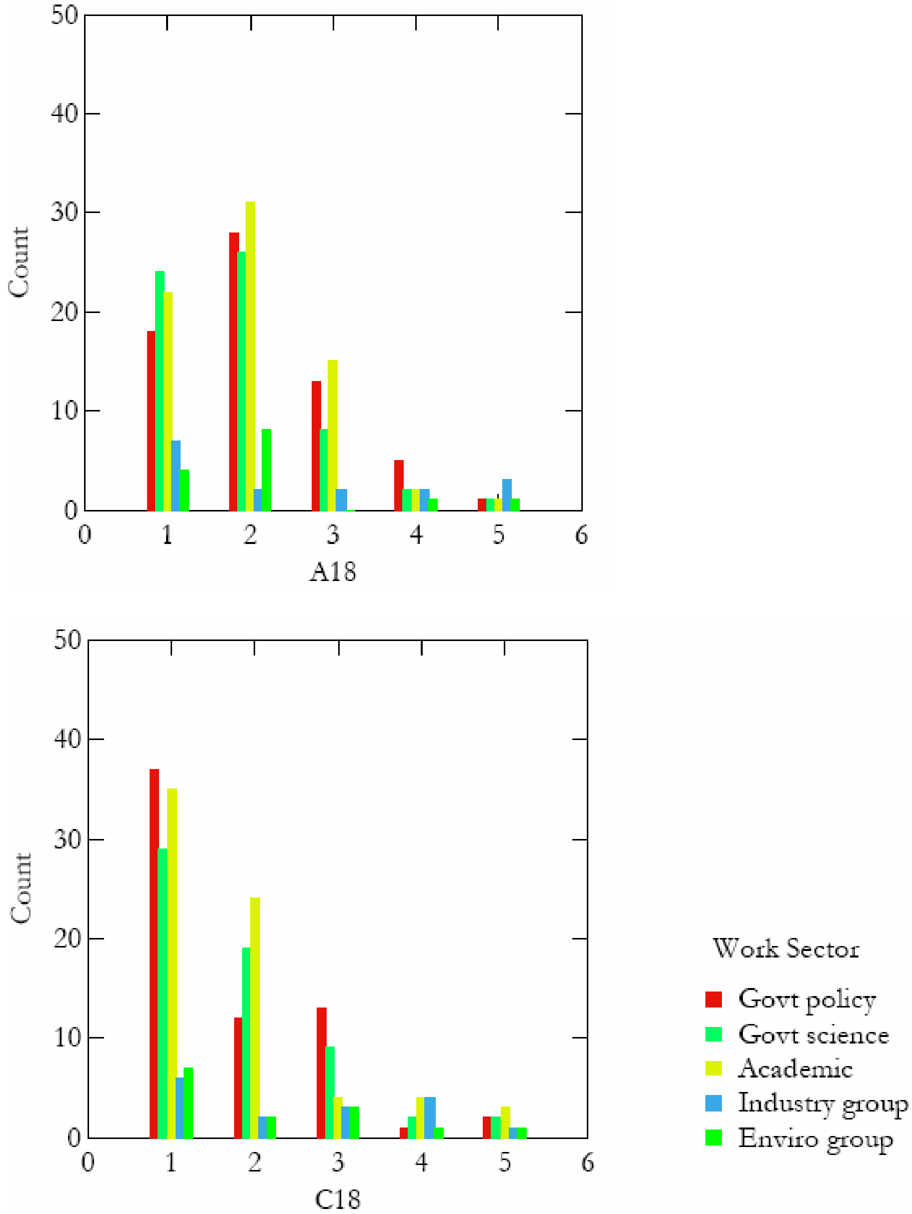

Fig. 4.12 'Please rank how important the following factors are in determining policy decisions.' Economic factors as an influence (A18); Political factors as an influence (C18) (1- most important; 5- least)

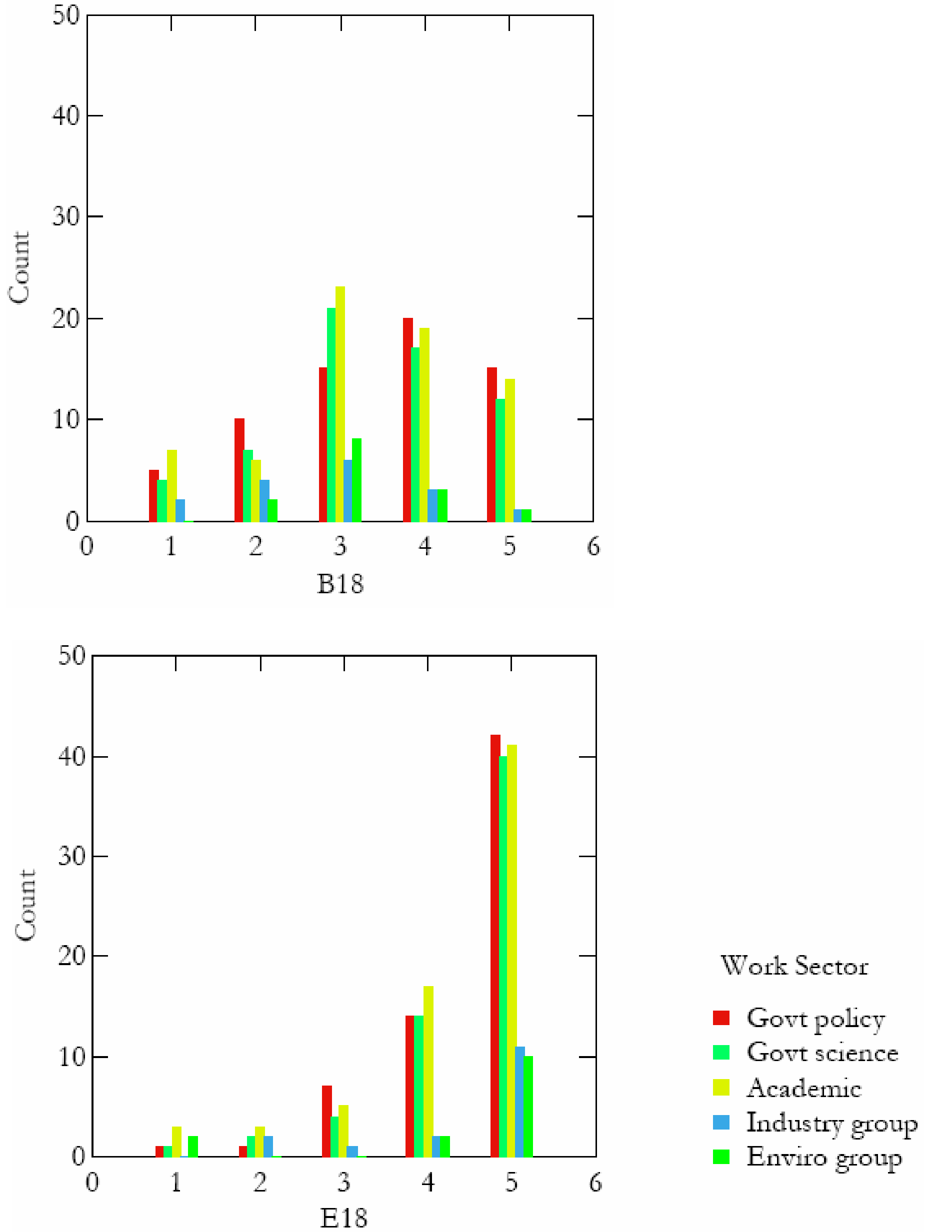

Fig. 4.13 'Please rank how important the following factors are in determining policy decisions.' Institutional factors as an influence (B18); Cultural factors as an influence (E18). (1- most important; 5- least)

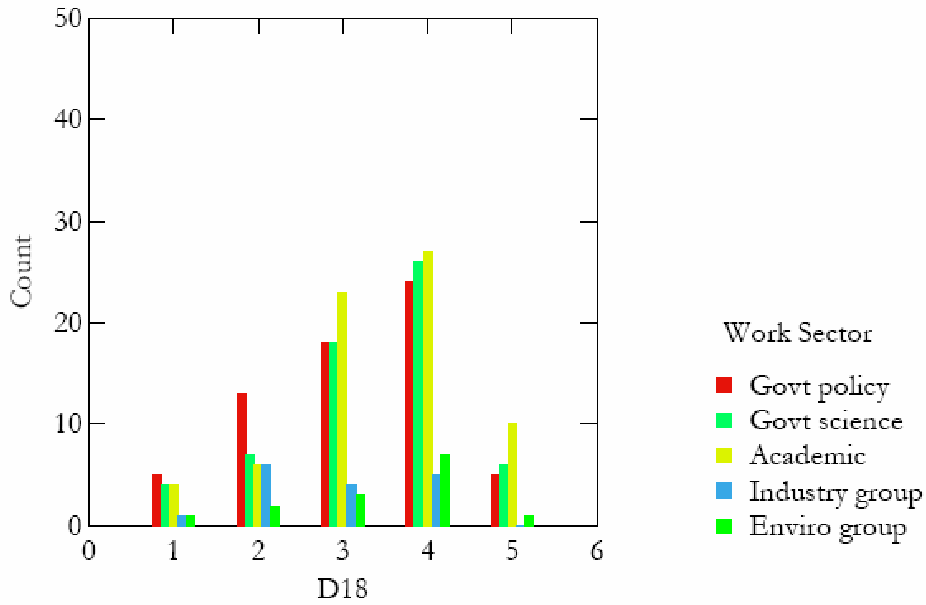

Fig. 4.14 'Please rank how important the following factors are in determining policy decisions.' Social factors as an influence. (1- most important; 5- least)

Once again, from the graphs above there is a strong signal that political (50.4%) and economic (40.9%) factors are a major influence on policy decisions, while cultural factors ranked lowest.

I was then interested in seeing if 'outside influences' had any effect on how the science was produced and presented so I asked in question 22: 'In your experience of reading scientific papers how often has the language, words, or phrasing used in a scientific paper indicated to you a political position or a personal belief held by the author(s) of a paper. The scale was: 1- Often, 2- Sometimes, 3- Rarely, 4- Never.

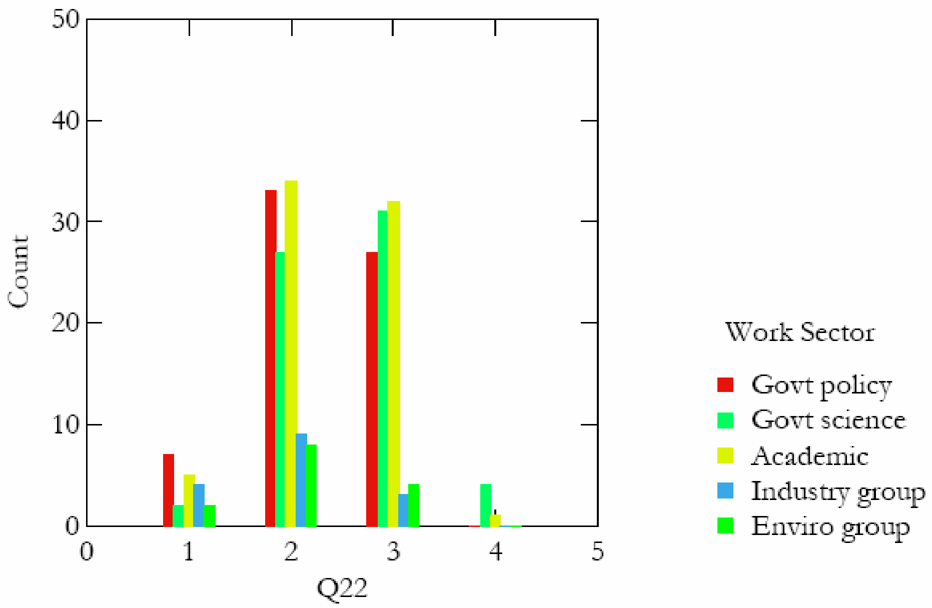

Fig. 4.15 Political position or personal belief being apparent in a scientific paper. (1- often; 4- never)

The pooled results show a fairly even split, with 47.6% of respondents choosing ‘sometimes’ and 41.6% choosing ‘rarely’, however more policy and academic workers chose ‘sometimes’. I next asked (question 23): ‘In your experience, how often has scientific research that has been commissioned or done by and environment or industry organisation been biased towards that organisation’s viewpoint? The scale was again: 1- Often, 2- Sometimes, 3- Rarely, 4- Never.

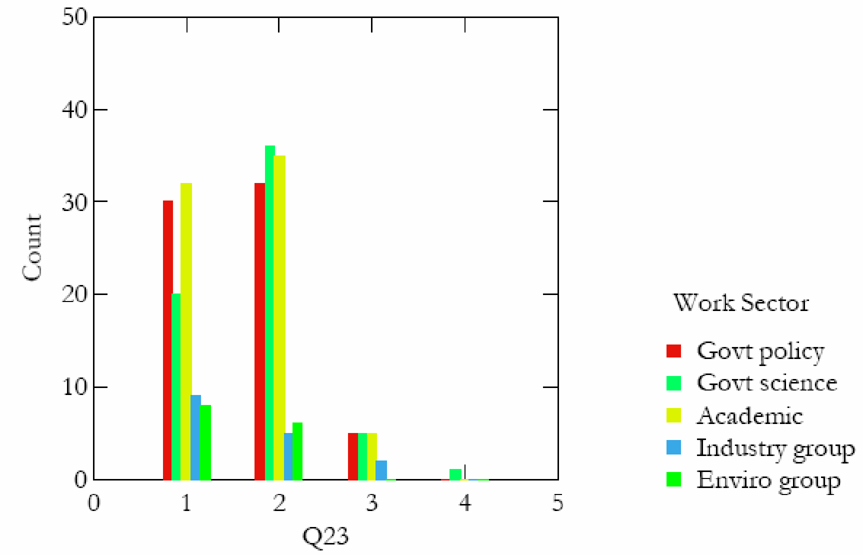

Fig. 4.16 Is bias apparent in environment or industry group research work. (1- often; 4- never)

This showed a strong positive response with pooled responses showing, for ‘often’ a response of 42.9% and ‘sometimes’ as 49.4%. This totalled to an ‘often and sometimes’ of 92.2%, compared with ‘rarely and never’ at a total of 7.8%. The inference here is that interest group research is often perceived to be loaded with beliefs and/or political positions. One interesting point was that environment and industry groups gave strong ‘often’ and ‘sometimes’ responses and one could surmise that they have a critical eye for research produced by their adversaries. The converse was to ask how government research is perceived, so in question 24: ‘In your experience, how often has scientific research that has been commissioned or done by a Government organisation been biased towards that Government organisation’s viewpoint?

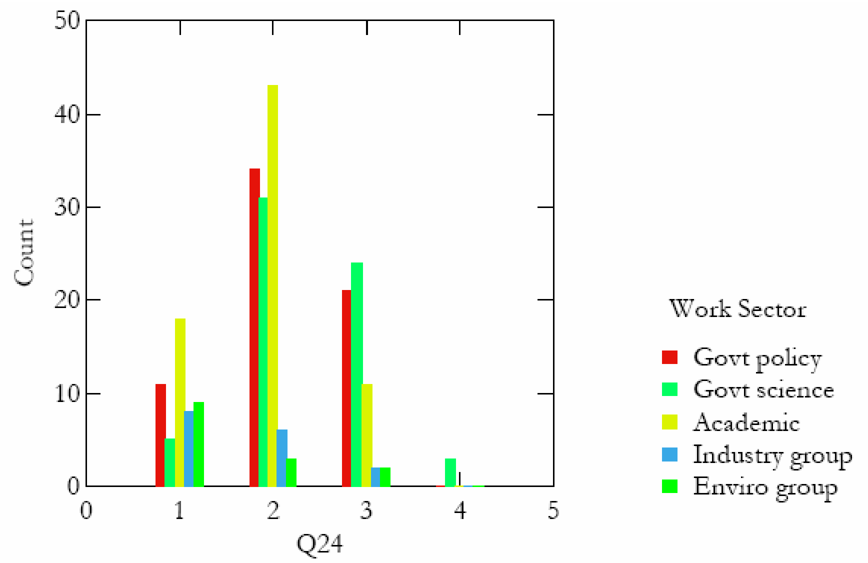

Fig. 4.17 Is bias apparent in Government research work. (1- often; 4- never)

In Fig. 4.17, the response was more spread out, with the strongest Government science, Government policy and Academic responses being 'sometimes'. Again, the environmental and industry groups gave strong 'often' and 'sometimes' responses indicating either a level of perceived bias in government research or that, if or when, the government research does not support their position they see it as being biased. The strongest 'rarely' response came from Government science, which could be expected.

In question 9 (Fig. 4.18), I drew back to look at respondents views on the broader issues of marine capture fishing. The statements used were designed to be strong and very specific in order to generate the clearest response.

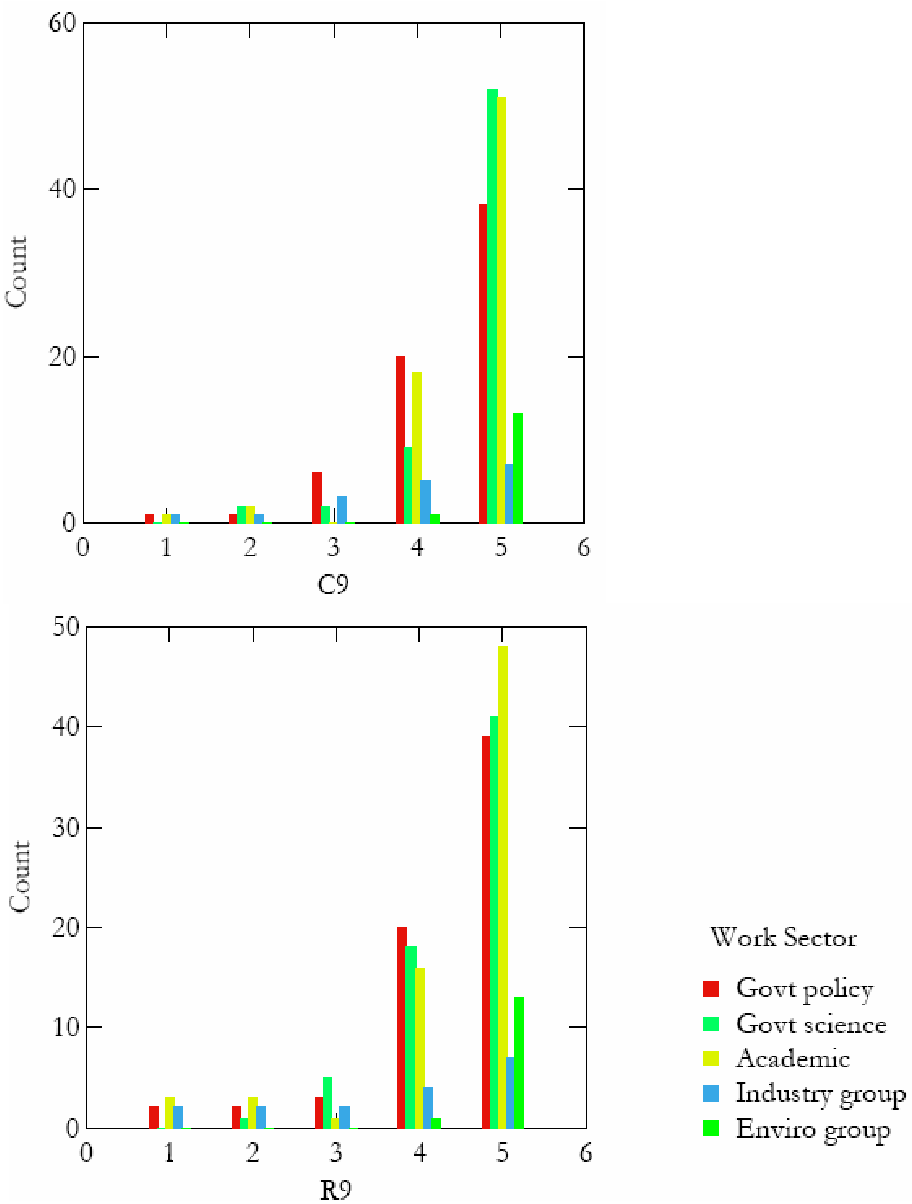

Fig. 4.18 Q.9. 'For the following statements, please circle your level of agreement.'
'Overfishing is not a problem; we can rebuild fish stocks' (C9) (note scale difference);
'Fisheries should be managed to maximised catch' (R9).
(1–strongly agree; 2–moderately agree; 3–neutral; 4–moderately disagree; 5–strongly disagree)

There is a very strong response; the majority of respondents disagree that overfishing is a problem and that fisheries must be managed for the maximum catch. Equally, the respondents that employment is not the most important concern in managing fisheries, but that fisheries policy is dominated by industry needs. One could infer that this indicates that it may well be the economic interests of industry rather than the political needs for employment is more prevalent in Australia than, for example, the EU.

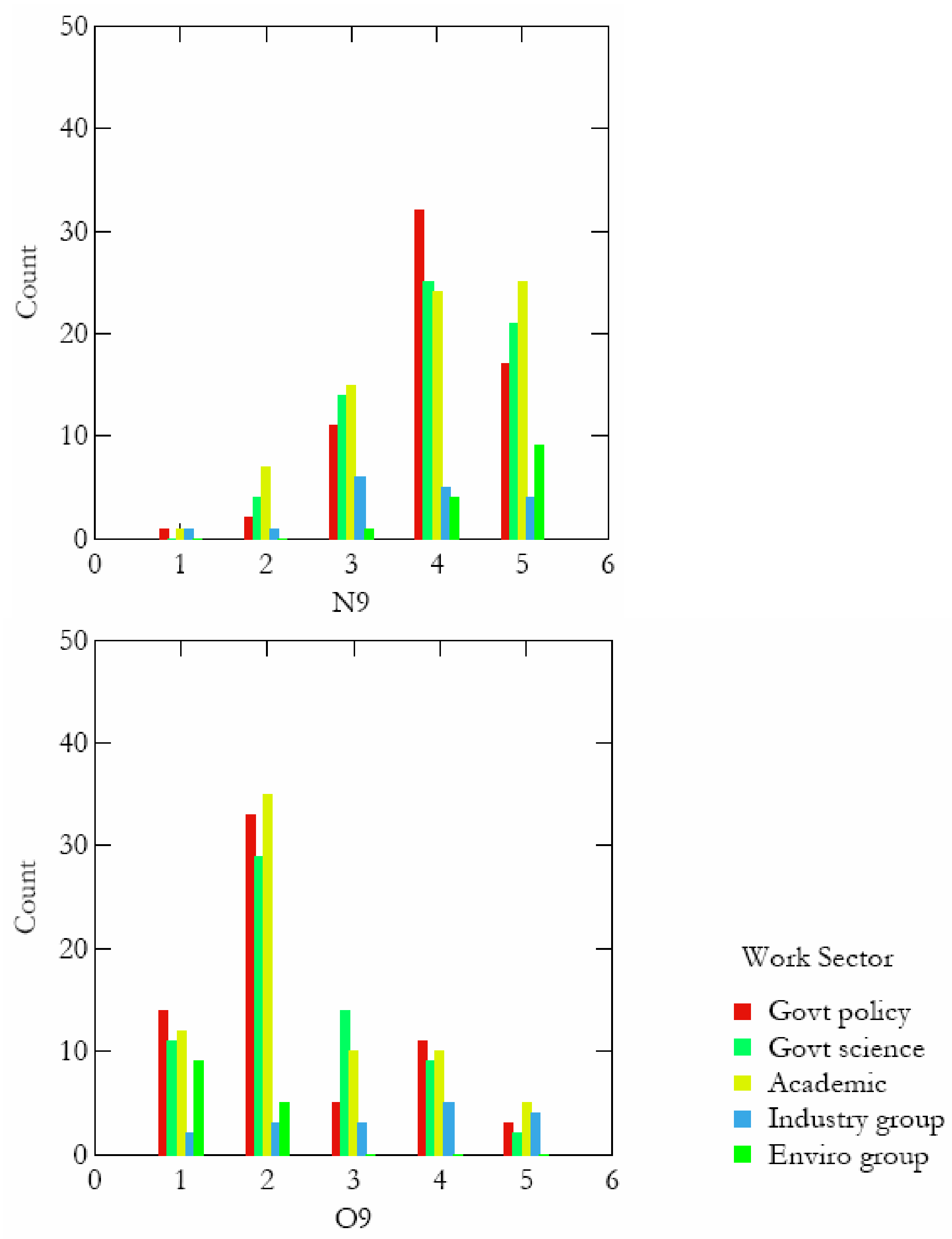

Fig. 4.19 Q.9. 'For the following statements, please circle your level of agreement.'
'Marine policy should prioritise employment' (N9);
'The needs of the fishing industry dominate fisheries policy' (O9).
(1–strongly agree; 2–moderately agree; 3–neutral; 4–moderately disagree; 5–strongly disagree)

4.3 Questions 19 and 20

Questions 19 and 20 were opportunities for the respondents to give written opinions on factors causing and reducing the science-policy gap. In Chapter Two, I identified from the written responses 27 causative factors and 31 reductive factors (see the appendices). These were ranked in Tables 4.1 and 4.2.

Table 4.1 Q. 19 comparative ranking of factors causing the science-policy gap.

Factor	Ranking				
	Pol	Sci	Ac	Ind	Env
Political interference.	3	**1**	**1**	**1**	**1**
Communication problems.	**1**	2	3	2	-
Lack of certainty in scientific results	2	5	5	3	-
Insufficient science research funding.	4	6	5	-	-
Lack of understanding by scientists of the policy process.	4	-	7	-	-
The kind of advice policy-makers need and what science provides.	4	6		-	-
Lack of longer term strategic policy.	5	-	7	-	-
Cultural differences between science and policy fields.	5	4	2	-	-
Policy-makers not good at asking the right questions of science.	6	4		-	-
Short-term nature of politics.	6	6	5	-	-
Policy has to incorporate economic, social, cultural and scientific considerations.	6	6	7	-	3
Scientific results used selectively.	6	4	6	-	-
Science not good at delivering answers in policy timeframes.	7	-	-	-	-
Policy failure on decision approach to management.	7	6	7	-	-
Not enough field research that is independent from fishing industry support.	7	-	-	3	-
Scientific culture of 100% surety before conclusive evidence given.	7	-	-	3	-
Greater accountability needed for decision-makers ignoring the science.	7	-	-	-	-
Lack of commonsense.	7	-	-	-	-
Cuts in catch are politically, economically, socially unattractive.	7	-	-	-	-
Scientists not generally represented in policy-making bodies.	7	-	-	-	-
Lack of understanding the role of science in policy-making by policy-makers.	7	6	-	-	-
Scientists able to give independent results without fear of political retribution.	7	6	-	-	-
Politics of economics – the power of primary industry to lobby government.	7	3	-	-	2
Conflict between long-term sustainability and short-term economic needs.	-	5	4	-	3
Lack of science education in policy.	-	5	5	-	-
Lack of quantitative data (notably in fisheries).	-	6	7	-	-
Unwillingness of scientists to promote a particular policy solution.	-	-	7	-	-
The inability of science and policy to listen to grassroots industry.	-	-	-	3	-
Unwillingness to accept the Precautionary Principle.	-	-	-	-	2

Table 4.2 Q. 20 comparative ranking of factors reducing the science-policy gap.

Factor	Ranking				
	Pol	Sci	Ac	Ind	Env
Better communication between science and policy-makers.	**1**	**1**	**1**	-	2
Greater interaction and integration between scientists and policy-makers.	2	-	3	2	-
More scientific research with a focus on policy context and policy needs.	3	-	5	-	-
Embed researchers in policy and *vice versa* for real world experience.	4	3	4	-	-
Policy-makers asking clearer questions.	5	5	-	2	-
Align long-term research and policy strategies.	5	2	-	-	-
Scientists being prepared to engage in public debate on contentious issues.	6	-	-	-	-
Policy can better accommodate uncertainty.	6	5	5	-	-
Integrate more fully the science requirements in policy management.	6	-	5	-	-
Policy needs to have longer term vision and resist short-term politics.	7	-	5	-	-
A greater understanding by scientists of policy process and requirements.	7	5	3	-	-
Make decision-makers more accountable.	7	4	-	-	-
Scientific funding independent and less reliant on industry support.	7	4	-	2	-
Measurable environmental objectives.	7	-	-	-	-
Get more scientists into policy-making bodies.	7	-	4	-	-
Change timeframes so that policy people stay longer in a role.	7	-	-	-	-
Involve all stakeholders in decision making.	7	-	6	-	-
Be clear about what questions science can answer and what it cannot.	7	-	-	-	3
Recruit professional resource managers instead of career public servants.	-	2	6	-	-
Good independent science should be the basis of policy.	-	2	2	-	**1**
Encourage policy areas to engage staff with scientific credentials.	-	3	-	-	-
A greater understanding of science by policy-makers.	-	3	5	-	-
More independence of policy-makers from Government to stop the use of selective science.	-	4	6	-	-
Minimize political/vested interest interference with science/policy process.	-	5	6	-	-
Recognize that science advises, it does not set objectives.	-	5	-	-	-
More scientifically trained politicians.	-	5	6	2	-
More openness and transparency in the processes.	-	-	5	-	-
Greater attention to the UN as a source of neutral science and policy.	-	-	6	-	-
Remove political and industry representation on research boards.	-	-	6	-	3
Keep scientific advice independent from the influence of policy-makers.	-	-	-	**1**	3
Agreed environment parameters so that economic value and the environment are protected.	-	-	-	2	-
More funding for broader, longer-term, ecosystem/biodiversity research.	-	-	-	-	3

The factors were then, for brevity, reduced to the 'top five' and the factors grouped into their types. 'Interference' ranked third for Government policy but first for all other work sectors.

Table 4.3 Q. 19 government policy ranking of the top five factors causing the science-policy gap and their type.

Factor	Rank	Type
Communication problems.	1	Dialogue
Lack of certainty in scientific results.	2	Understanding
Political interference.	3	Interference
Lack of understanding by scientists of the policy process.	4	Understanding
Insufficient science research funding.	4	Independence

Table 4.4 Q. 19 government science ranking of the top five factors causing the science-policy gap and their type.

Factor	Rank	Type
Political interference.	1	Interference
Communication problems.	2	Dialogue
Politics of economics – the power of primary industry to lobby government.	3	Interference
Cultural differences between science and policy fields.	4	Understanding
Science not good at delivering answers in policy timeframes.	4	Understanding

Table 4.5 Q. 19 academic ranking of the top five factors causing the science-policy gap and their type.

Factor	Rank	Type
Political interference.	1	Interference
Cultural differences between science and policy fields.	2	Understanding
Communication problems.	3	Dialogue
Conflict between long-term sustainability and short-term economic needs.	4	Interference
Lack of certainty in scientific results.	5	Understanding

Table 4.6 Q. 19 industry group ranking of the top five factors causing the science-policy gap and their type.

Factor	Rank	Type
Political interference.	1	Interference
Communication problems.	2	Dialogue
Lack of certainty in scientific results.	3	Understanding
Not enough field research that is independent from fishing industry support.	3	Independence
Scientific culture of 100% surety before conclusive evidence given.	3	Understanding

Table 4.7 Q. 19 environment group ranking of the top five factors causing the science-policy gap and their type.

Factor	Rank	Type
Political interference.	1	Interference
Unwillingness to accept the Precautionary Principle.	2	Understanding
Politics of economics – the power of primary industry to lobby government.	2	Interference
Conflict between long-term sustainability and short-term economic needs.	3	Interference
Policy has to incorporate economic, social, cultural and scientific considerations.	3	Understanding

A similar process as used in question 19 was followed for question 20. Better communication was very important for science and policy but both industry and environment groups had independent science as most important; industry groups wanted 'independent interference-free' science and environment groups wanted 'independent science-led' policy.

Table 4.8 Q. 20 government policy ranking of the top five factors reducing the science-policy gap and their type.

Factor	Rank	Type
Better communication between science and policy-makers.	1	Dialogue
Greater interaction and integration between scientists and policy-makers.	2	Integration
More scientific research with a focus on policy context and policy needs.	3	Integration
Embed researchers in policy and *vice versa* for real world experience.	4	Understanding
Policy-makers asking clearer questions.	5	Understanding

Table 4.9 Q. 20 government science ranking of the top five factors reducing the science-policy gap and their type.

Factor	Rank	Type
Better communication between science and policy-makers.	1	Dialogue
Align long-term research and policy strategies.	2	Integration
Recruit professional resource managers instead of career public servants.	2	Dialogue
Good independent science should be the basis of policy.	2	Science leads policy
Embed researchers in policy and *vice versa* for real world experience.	3	Understanding

Table 4.10 Q. 20 academic ranking of the top five factors reducing the science-policy gap and their type.

Factor	Rank	Type
Better communication between science and policy-makers.	1	Dialogue
Good independent science should be the basis of policy.	2	Science leads policy
Greater interaction and integration between scientists and policy-makers.	3	Integration
A greater understanding by scientists of policy process and requirements.	3	Understanding
Embed researchers in policy and *vice versa* for real world experience.	4	Understanding

Table 4.11 Q. 20 industry group ranking of the op five factors reducing the science-policy gap and their type.

Factor	Rank	Type
Keep scientific advice independent from the influence of policy-makers.	1	Interference
Greater interaction and integration between scientists and policy-makers.	2	Integration
Policy-makers asking clearer questions.	2	Understanding
Scientific funding independent and less reliant on industry support.	2	Independence
More scientifically trained politicians.	2	Understanding

Table 4.12 Q. 20 environment group ranking of the top five factors reducing the science-policy gap and their type.

Factor	Rank	Type
Good independent science should be the basis of policy.	1	Science leads policy
Better communication between science and policy-makers.	2	Dialogue
Keep scientific advice independent from the influence of policy-makers.	3	Interference
More funding for broader, longer-term, ecosystem/biodiversity research.	3	Independence
Remove political and industry representation on research boards.	3	Interference

4.4 Interview results

Again, as in questions 19 and 20, the interviews were thematically analysed and the factors ranked by the earliest appearance and frequency of mention. The table below shows the factors and their ranking within each interview.

Table 4.13 Interviewees: Ranking of factors causing the science-policy gap.

Factor	Ranking							
	AB	CD	EF	GH	IJ	KL	MN	OP
Bureaucratic agenda.	**1**	-	-	-	4	-	-	-
Political interference.	2	-	6	-	2	-	4	4
Scientific results used selectively.	3	5	-	2	-	-	-	-
Conflict between long-term sustainability and short-term economic needs.	4	7	4	-	3	-	5	3
Insufficient science research funding.	5	9	-	-	-	-	-	**1**
Communication problems.	-	4	-	3	-	-	-	-
Science not good at delivering answers in policy timeframes.	-	2	-	-	-	-	6	-
Lack of certainty in scientific results.	-	12	3	-	-	-	4	-
Lack of understanding by scientists of the policy process.	-	-	-	-	-	4	-	-
Lack of longer term strategic policy.	-	10	7	-	-	3	-	-
Science advice going into the policy or management decision framework is being ignored.	-	-	-	-	**1**	-	**1**	-
Not enough field research that is independent from fishing industry support.	-	-	-	-	-	-	-	2
Scientific culture of 100% sureness before conclusive evidence given.	-	3	-	-	-	-	-	-
Cultural differences between science and policy fields.	-	**1**	**1**	-	-	-	-	-
Politics of economics – the power of primary industry to lobby government.	-	11	-	-	-	-	5	4
Short-term nature of politics.	-	8	5	-	-	-	3	-
The science doesn't exist, or there's no science that can inform policy or help fill a policy gap.	-	-	-	**1**	-	-	-	**1**
The kind of advice policymakers need and what science provides.	-	6	2	**1**	-	**1**	2	-
Policymakers are not clear about what they want from science for making tight strategy.	-	-	-	-	-	**1**	**1**	-
Lack of understanding the role of science in policymaking by policymakers.	-	-	-	-	-	2	-	-
Lack of quantitative data (notably in fisheries).	-	-	-	-	-	-	-	**1**

AB. Recently Chief Scientist for an Australian State advising the Premier and Cabinet.
CD. Senior policy adviser for a major Australian Commonwealth research and policy organization with an ocean science focus.
EF. Director of a major regional fisheries management organization.
GH. Director of a major Australian Commonwealth research and policy organization with an ocean science focus.
IJ. Australian Marine Project Leader for a major international conservation organisation.
KL. Executive Director of a major Australian fisheries industry organisation.
MN. Recently a senior manager in a major Australian fisheries management organisation.
OP. Senior marine campaigner for a major Australian conservation organisation.

From there, I placed the factors into their types and ranked them numerically from most frequent to least.

Table 4.14 Interviewees: Types causing the science-policy gap and their ranking.

Type and Ranking							
AB	**CD**	**EF**	**GH**	**IJ**	**KL**	**MN**	**OP**
1 Interference	1 Understanding	1 Understanding	1 Research lacking	1 Interference	1 Understanding	1 Interference	1 Research lacking
2 Interference	2 Understanding	2 Understanding	1 Understanding	2 Interference	2 Understanding	1 Understanding	1 Interference
3 Interference	3 Understanding	3 Understanding	2 Interference	3 Interference	2 Integration	2 Understanding	1 Understanding
4 Interference	3 Integration	4 Interference	3 Dialogue	4 Interference	3 Interference	2 Integration	2 Independence
5 Independence	4 Dialogue	5 Interference			4 Understanding	3 Interference	3 Interference
	5 Interference	6 Interference				4 Interference	4 Interference
	6 Understanding	7 Interference				4 Understanding	
	7 Interference					5 Interference	
	8 Interference					6 Understanding	

AB. Recently Chief Scientist for an Australian State advising the Premier and Cabinet.
CD. Senior policy adviser for a major Australian Commonwealth research and policy organization with an ocean science focus.
EF. Director of a major regional fisheries management organization.
GH. Director of a major Australian Commonwealth research and policy organization with an ocean science focus.
IJ. Australian Marine Project Leader for a major international conservation organisation.
KL. Executive Director of a major Australian fisheries industry organisation.
MN. Recently a senior manager in a major Australian fisheries management organisation.
OP. Senior marine campaigner for a major Australian conservation organisation.

Finally, I compiled the 'top five' of types for the interviewees. Note how *CD*, a senior policy adviser for a major Australian Commonwealth research and policy organization, and *EF*, the director of a major regional fisheries management organization, ranked interference lower while interference was more highly ranked by the other interviewees.

Table 4.15 Interviewees: Top five types causing the science-policy gap.

Interviewee	Ranking and Type				
	1st	2nd	3rd	4th	5th
AB	Interference	Interference	Interference	Interference	Independence
CD	Understanding	Understanding	Understanding	Dialogue	Interference
EF	Understanding	Understanding	Understanding	Interference	Interference
GH	Research lacking	Understanding	Interference	Dialogue	-
IJ	Interference	Interference	Interference	Interference	-
KL	Understanding	Understanding	Interference	Understanding	-
MN	Interference	Understanding	Understanding	Interference	Interference
OP	Research lacking	Interference	Understanding	Independence	Interference

Below are the quotations from the full interview transcripts (Appendix 1) that relate directly to the questions about the causes of the science-policy gap. These parts were used in developing the factors and types tabled above. These quotes are extracted from the complete interviews as they show the factors and types when they appear in the interview. I recommend reading the entire interviews (Appendix 1) as they are a unique insight into the executive levels of fisheries research and management, a perspective rarely seen; especially *AB*, recently the Chief Scientist for the DPAC of an Australian State.

***AB*.**

At the time of interview, AB had recently ended his tenure as Chief Scientist for an Australian State. In this role he gave formal advice to the Premier and the Department of Premier and Cabinet (DPAC).

How do you define the science-policy gap?
AB. …the role of the bureaucracy, the role of the weak bureaucrats in the system.

AB. I described them as jelly-backed, or in other terms, people with a wishbone and no backbone, basically, actually slow up the system. They're very reluctant to carry good policies through their agency, and the initiatives of their lower people in the agency might develop; they're very reluctant to actually take that up through the system, because a) it's hard work; b) they often get knocked back, and it can actually create a tension, I would call it a creative tension, but they don't think of it in those words, a tension with their peers. And maybe other ministers. So there's often a problem where those bureaucrats don't do it. And I see an emerging trend in Australia, in the environment more generally, where there's no advocacy for the environment, and it's really the role of enviro- um, bureaucrats to do that in some ways, or certainly ministers.

AB. First of all, you have the agencies run by bureaucrats who don't stand up for what needs to be done, the Jelly-backs, and then the institutional framework is changed. Those that can are now longer able to.

For you, what is the main cause of the science-policy gap?
AB. The level that I'm talking about really is at the director-general/deputy director-general or secretary assistant, first assistant secretary kind of level. Very senior in the agencies. And it's those people who basically have to interact with the minister, to advise the minister, ah and they basically manage that business of putting submissions to cabinet, to treasury and so on about how they should be doing their

business. So it's at that level, I think, where there's a failure in, in the public service as we know it, the institutional arrangements, in Australia at the moment.

AB. … I've worked in minister's offices for a period of about ten years, so I've seen what comes into the office, the way the advice is given; I've sat in those discussions between ministers and their senior staff, and I've worked in the department of premier and cabinet here, for three years.

AB. So I've seen what's going through the cabinet office, and interacted with minsters directly and sat in meetings with ministers and their senior policy staff, and also I've done work on for example, whether it should be fisheries or another agency that manages the marine environment. So I did that, I ran a whole policy formulation program in that area. So I've watched those things happening, and I've also sat on those high level organisations, chaired committees, inter-agency working groups across this government and ah, been a commissioner on the Australian Heritage Commission. At all of those levels, I see this pervasive problem of senior bureaucrats, permanent secretaries and things, trying to subdue the type of advocacy that comes from the, from within the agency, and the propositions, and the policy advice, trying to dumb it down, trying to make it easy, trying to make their own jobs easier and so on.

AB. But, but the problem of the Jelly-backs is much more acute than that, I think.

AB. And the agenda, to go to your particular question that the agenda that is being run is a personal agenda, generally speaking. So most of those bureaucrats who get to that very high level, their first consideration is their own job, their own self-preservation. Their own comfort, actually. And so they always think about the, the issue, maybe not consciously but certainly there in the way that they respond, they think about it in terms of, 'Is this going to be difficult? How is it going to set me up for my next kind of, job am I continuing in this thing?' Because I know I'm on a five year contract and, really the way I get my contract, extend it, is by appearing to be a good guy, a nice guy, and all of that sort of stuff. And so they're thinking to themselves, 'What's this going to do for my future prospects? How is it going to influence the way not just the ministers perceive me and not just the way the public perceives me in this job but my peers?'

AB. Because when I get interviewed, at my next job, it's going to be my peers who sit there on that interview panel and give advice, and they're going to be judging me in the context of my interaction with them over the last five years. And this is the thing that basically, they're, they're not thinking about, primarily about the job that they're supposed to be doing, they're thinking about the job that they want to do, the job that they would like to be doing in the future, their relationship, their good positive relationship with government ministers and their peers rather than getting the precise job done. And we don't have a system in Australia that requires people to do their job.

How do you see the science-policy gap operating in practice?
AB. Here's an example: In most conservation organisations, where they have a, a sort of government policy commitment to achieve a comprehensive, adequate and representative reserve system, that's a, one of their mission statements, then the simple KPI is, 'What proportion of the state is in the reserve system?' So it goes from 13.2 to 13.3% in a year, and you've actually achieved something.

AB. The fact that there's no actual measure of comprehensiveness, adequacy, representativeness in there, or that, you know, actually the land that was acquired to make that, you know, tenth of a percent difference, was flogged out bloody pastoral country that has nothing, no value, no biodiversity values, and then, having got there, how is this conservation estate being managed?
Is the biodiversity actually being conserved?

AB. That's why we're setting aside all of this land, specifically not because we just want land, but because we want it to conserve biodiversity. There is no measure of the effectiveness of the conservation estate. And so that whole system fails. You know, I think the, the director general, or the secretary of the department where they have a conservation estate should be beholden to ensure that the biodiversity values on the land that they have is conserved in perpetuity, which is what it's all about.

AB. Those, those concerns about the environment, they need to be on the agenda, and they need to be articulated. I think; I come back to that point that we need advocacy for the environment. We need advocacy for sustainability and for too long, that hasn't existed. So somehow we've got to find a way to bring the issues that come out of scientific endeavour. Well, let me just say, I think we've gotta have a better level of support in Government for science, for research of all kinds. And in Australia as it is at the very lowest ebb of its investment in knowledge. And I talk about knowledge rather than science, because you get a scientific finding, and that can be translated into an application that we can do something with. And I think about improving our knowledge, our level of understanding of how the world works and how human beings, and how humans themselves work cos science includes the study of life on earth and the human body.

AB. I think we've gotta have that better level of investment, and a part of that has also to be an understanding that the knowledge that's generated belongs to the community. And so there has to be a, an acceptance of the capacity of scientists and those knowledge brokers to actually spell out their knowledge. Ok? The universities have failed in the last twenty years, ten years in particular for obvious reasons, but the universities have failed to be knowledge brokers in my opinion, they've become much more businesses, competing against each other and also, making sure that they were sustainable economically, that economic driver has actually lessened the capacity of the university to articulate and take the knowledge to community broadly, as well as students.

Which real world situation can you give as an example?
AB. … I think the whole discussion about the economy, and the way those discussions are framed, that will always, and it has always, and I hope it doesn't always in the future, but at the moment the system that prevails mean that all of those arguments are privileged over anything lesser. That is to say anything to do with the community, anything to do with ah, you know, social good, anything to do with ah, education even, anything to do with the environment, sustainability, those are, those arguments about GDP, and about the economy and jobs, they will prevail at the moment. How do we do something about it?

AB. I think one of these real challenges is for us to change the nature of the economic discussion, of the nature of the understanding of what, what good meters of the economy might be, that include all of the other quality of life measures, for example, and the environmental measures. So we move from a daily broadcast, or you know, a many times a day broadcast of how the economy is doing, as measured by the share market or the interest rates or so on, to an equivalent reporting and in people's consciousness of the way the society's doing, or the wellness index or something like that. And as I've said, the current metrics that are used for the economy are a complete pack of cards; GDP is a nonsense.

AB. So we've gotta break that nexus, I think, where that is the thing that people use as the yardstick, it's in our face, in our mind, it's in our ears every day. The second thing is, that I think we're at the point now, and maybe with the present national leadership, we might get, might take advantage of this opportunity, where other things are on the agenda. That is to say, you know, there's a lot of discussion about climate change and how that's going to affect us. And climate change is a, is essentially a, well I describe it as a market failure, but actually xxx says, 'No it's not a failure, that's exactly the way the market works'. And that's exactly what I'm saying, it is the pack of cards that drives... all of the drivers in there are completely wrong. They will, they will destroy us if we leave it the way it is. So, we need to change the metrics, we need, we need, the capacity to actually.... bring those discussions about the environment into the public domain more clearly.

What main socio-political tensions do you think are behind the science-policy gap?
AB. Ok. I suppose a number of dimensions here. Firstly there is a club. There is no doubt that there is a notion of a club, whether it actually exists as such or not. Certainly in Canberra, the so-called Mandarins get together from time to time, and they know all about their Mandarins and their, the so-called what we might call McCumquats as well, the people who aren't quite Mandarins yet. Ok? So there's that, a very clear understanding in that system, and they buy. They buy, they compete with each other, they, they make sure that they all know who's doing what, and so on. And that's part of the game that they all play. It's not, I don't think, so obvious in say, in xxx, but I do know that all of those CEOs of departments get together on a fairly regular basis, and they kind of eye each other of, like a pack of dogs, really. And they piss on the posts, and so on. They do that stuff, and it really happens. So there is a kind of culture where it's, it's generally you've got a much better chance of getting on if you're one of the boys. And I say 'boys' quite deliberately, because by far the majority of these people pissing on posts are boys, and they keep it that way.

AB. There certainly is a sort of notional, professional hierarchy. So if you've got economics or legal qualifications, as the CEO, you are thought of more seriously than if you, and engineers are up there, engineers because, you know, it's a digression but basically engineers are taught to solve problems, and most of those problems happen to be linear, but that's a side issue. But they have that, and they think of themselves as problem-solving professionals, rather than just engineers. So they're all up there in the first echelon, and someone with technical skills in, you know, the environment, or um, let's not put too fine a point on it, but someone who might have been a curator of paintings, for example, and that was their professional domain, they're not given a look-in because they don't understand the real issues.

AB. So basically you've got a situation that's emerged in Australia in the last twenty years where the strictly economic rationalist theory has come to be the dominant paradigm of government, throughout all of the jurisdictions in Australia.

AB. And, and it works, it manifests at all sorts of levels, but as an example, in this government here, for example, if a cabinet minute, just supposedly if a cabinet minute comes into a cabinet office, that's about implementing a government policy for sustainability, you know. And everyone has said we want to be a sustainable government and you know, those commitments have been made, this policy is cabinet minutes comes in. And it says, 'Ok, this is what we want to achieve, and it's got long-term benefits to the community, to the economy, to the environment, blah blah blah, and it's gonna cost, you know, for argument's sake, $20 million over ten years'.

AB. The fact that is says 'this is going to cost something' means that it goes into the cabinet room; it's immediately referred off without any real discussion to the expenditure review committee. The expenditure review committee is shared by the treasurer, and has a couple of other ministers, and all the rest of the other people around the table are treasury officials. And they will say, 'Um, we've assessed this, and we note that it's going to cost $20 million over ten years. We don't think that the budget can stand this extra pressure'. And that's it! Regardless of the fact that it's a policy position that comes in, those treasury officials use their power to basically govern all decisions of government, to control all decisions of government.

AB. And that's not an unusual thing, that's using the example that I see from my observations, working in premier and cabinet here. That, that is common in all State and Commonwealth jurisdictions, that the financial advice somehow overrides any real policy considerations, regardless of whether they're for the good of the community or not.

How do the decision-makers fit into the play between science, policymakers, and the science-policy gap?
[See above]

What is the dominant culture in marine resource management and how does this affect the science-policy gap?
[Not directly answered, see above]

CD*. At the time of interview, CD was a senior policy adviser for a major Australian Commonwealth science research and policy organisation with an ocean science focus.*

How do you define the science-policy gap?
CD. I haven't tried to put words in a, a definition sense, but ah, I know it when I see it, so I say there's evidence of ah, gap. But it's a cultural issue, which is precisely how I would describe it. It is essentially an issue of, policy people having particular needs and expectations of science and scientists having different perspectives and needs, and the two groups not actually explaining to each other what their needs and perspectives are. So it's essentially a cultural issue, to my mind.

For you, what is the main cause of the science-policy gap?
CD. Well ah, I think there are several causes and the attributing one has been the most significant, I think would be a little bit hard for me in this ah, start writing all my thoughts down, but I think some of the issues that relate to the culture are that policymakers need science to help them make their decisions, but they need, the information in a timely way. And only sufficient information for them to make a policy judgement. Scientists, on the other hand, expect precision and scientific certainty. And are prepared to work for years to get scientific certainty; they're not comfortable in putting caveats and qualifiers on the advice that they give, and I think that leads to part of the difficulty, because the scientists will say, well I haven't got the results fully worked out, and the policymakers will say, 'Well, give me a hunch', and the scientists will feel distinctly uncomfortable, ah about that.

CD. I think some of the issues too relate to the pathway by which the scientific information is made available, ah to policymakers, and I think that's an issue which really has to be examined to close the gap. And I say that because the scientists, ah typically, will want to have their work published in referee journals, and will make the assumption that once a paper is published, then it's accessible and understandable to the policymakers or whoever else needs to see it. Whereas the policymakers are not inclined to be scanning the scientific literature. They need another layer of interpretation, which will come from the people who are the analysts of the scientific research, and those analysts can in fact be scientists themselves, but they need that information instilled into the key message, the key implications and so on.

CD. Scientists as a group are generally not good at translating their work into the language the layperson or the politician or the policy adviser can take and use immediately. Cos I think that's a significant issue. And I think we've seen plenty of examples of the pathways for the information breaking down. And we see examples of that; say in climate science, where there are several ways of publishing the scientific information in the literature and in conferences and so on.

CD. But the policymakers are scattered across various institutions and organisations, in international bodies and so on. And they each need to have the information delivered to them in a way in which, their culture and timing needs and so on operates. And it's not a good match between the two sets of mechanisms. I think there's another cause of the policy gap, and that is what's the prime motivator for individuals to do their work? And this is a comment about, ah some of the scientists I see operating day to day, and that is that for the scientists, the advancement of their careers is driven by the number and quality and reputation of their scientific publications.

CD. That becomes the driver for the nature of the research they do, whereas the policymaker wants to have the information from the scientists, irrespective of whether it's actually brilliant science that will get published and will advance the scientist's career. So there can be a fundamental tension there, where a policy adviser needs to get information which might, say, show trends over time of a certain parameter within the environment, or within climate. But the scientists will say, ah I'm not interested in just monitoring a particular parameter, because, that actually won't get me a referee publication, or it won't get me a PhD, or whatever it is. The policymaker feels constrained in her ability to direct the scientist to produce a particular piece of work. The scientist will say, also, you can't constrain the work that I do, because I need to follow the line of scientific enquiry and see where the line of thinking takes me, rather than answer your particular commission need. So you know, there's several layers of cause there.

How do you see the science-policy gap operating in practice?
CD. … in marine science maybe the issues are a little bit simpler because I'm familiar with say the CCAMLR environment, where the science has come to the point where, it has a clear understanding about where the science can actually make a difference to the policy judgement, and we have a scientific committee within CCAMLR which can help design the programs.

CD. And as it were, tell scientists, these are the things where we need your advice and your scientific evidence. So that can work quite well. But in other areas of science they don't have a body there, which is, which all the science is absorbed, analysed and considered before going to the policymaking forum.

CD. Ah, I was gonna mention before, the, in the climate world, where suddenly there's this huge amount of public awareness and concern and therefore political concern about it. A great hunger for information. And that's manifested itself in, a proliferation of advisory bodies, councils, intergovernmental bodies and so on. All after this information. But all of these players in the policy side of the market are not coordinating their needs in any political way, and they're going to different scientific groups asking for the information that they want. And the scientists I think are almost getting to the point where they're saturated with requests. And also confused about who is the prime user of the information that they want to generate. Ah, and that leaves the potential for there to be gaps, where things don't get done, or for things to be oversupplied, or there to be conflicting evidence and so on.

Which real world situation can you give as an example?
[See above]

What main socio-political tensions do you think are behind the science-policy gap?
CD. Well, there's an issue of objectivity of the science. I mean I think there's some real issues about policymaker's cherry-picking the science that suits the answer that they want to achieve. I think that's a real risk in many areas. I think there's a lot of cultural issues that we, we mentioned before, are in there as well because sometimes the, the scepticism that policymakers might have for how scientists work and whether or not they understand the issues, are prepared to produce information, in a, in a timely way, that's addressed the very specific issues. So that's a question of the control with which the policymakers feel that they have over the scientific community and its ability to deliver to their needs. Those sorts of issues.

How do the decision-makers fit into the play between science, policymakers, and the science-policy gap?
CD. I think the decision-makers like to feel that they're ultimately the clients of the science, and therefore should have the greater say over what the science, what science should be done. Policymakers would like to feel that they can control access to the funds and sort of apply pressure to science, to make sure it delivers only on their needs, I think a lot of policymakers are very sceptical about the pure sciences which are simply, I shouldn't say simply, but are aiming at describing the world and looking at things which may

one day be useful but aren't immediately useful, because the policymakers almost inevitably have a short-term horizon; they're looking at the next one, two, three years, and policy decisions of course are looking at electoral cycles.

CD. Oh predominantly the decision-makers you know, at the political level with ministers and so on, but ministers are very much influenced by the quality of the policy advisers which operate in government and various advisory bodies and so on. So the job of the scientists is to convince the policy advisers in the bureaucracy and the expert panels appointed by government and so on, cos if they can't convince them, they can't convince the ministers. So that's really where the influence has got to be exercised and the condensing argument to be made.

CD. … I think there's a long way to go to build trust in the relationship. I think, scientists resent the scrutiny that comes from the policymakers looking at their work and you know saying that's not the answer I needed, or it's not quick enough or whatever, ah I think they resent what they see as sort of naive interpretation of the value of their work, and so on. In some ways, I think from the policymakers perspective, they can be reasonably sceptical about whether or not scientists are telling them the full story and giving them all the information they need to make a balanced set of information to make informed judgements. And we've seen, you know, several examples where scientists have been selective in their use of data. Or the data's been presented in a way that it can be used selectively. And that doesn't help produce the trust that you need.

What is the dominant culture in marine resource management and how does this affect the science-policy gap?
CD. … ah that's a good question. I think the, there's still a sense that, and this would be reflecting a personal concern of mine; that people are prepared to take policy decisions on the base of insufficient, ah information, and be too optimistic about the level of resource that's, available. And use lack of certainty as an excuse for not having a, you know, a conservative approach to stock management, that's a real issue.

CD. Well, that's a culture in the policymaker's perspective of trying to look after the industry and pressure groups' perspective, and that's potentially quite dangerous because you know, you get a short-term political fix and have long-term you know, failure. Because decisions are, you know, not sustainable.

CD. … part of the problem is that policymakers on the whole tend not to be in that part of the world long enough to pick up all the issues and the nuances, the policymakers are often looking at a very short timeframe. In some situations they may, might only be looking for enough confidence to be able to get through the next meeting, you know. And we're not talking about the next year or decade of this issue; that's left to others not addressed at all. So, I certainly agree that there's a problem created by the ongoing movement in the policy advising and policymaking force.

CD. … I mean a lot of them just simply want to make a difference, and sometimes that might require making a decision almost on the basis of what's good for their reputation, rather than what might be good for ah a long-term, you know, what's good for a long-term policy outcome. And I think that's significant. And we certainly see that in the advocate level of policymaking, but you can get a lot of short-term fixes without a, you know, a long-term strategic view about the consequences, and the accumulative effects of certain kinds of decisions.

JS: And those short-term fixes, what's their general intent, what are they trying to fix in terms of?

CD: Oh, placate stakeholders you know, in the short-term, and maintain peace and harmony around the negotiating table, or to be able to come out with a press announcement that looks impressive on the day.

CD. A lot of policymakers are not prepared to make a decision which won't generate a recognised, a positive benefit until the next decade. That'll look like inaction and you know, lack of concern, even if in terms of the, say for the good of managing a fish stock, you know, you need to make a tough decision now, rather than a popular decision.

JS: So they'll postpone, have a closure or...

CD: They may well do, they may well do, yeah, the attitude that well one more season, or couple more seasons at this level isn't going to change the overall outcome, so let's live with that. You know, let's leave it to my successor, dealing with the hard issues.

CD. … Well each level of the policymaker will have different constituents, but at the top level, you know, the policymakers want to basically, on the whole, they want to look after the fishing industry and ah, and so on, and that's obviously got community benefits too, in terms of access to cheap resources, and so on. At other levels, the policymaker might be trying to appease other stakeholders who might be environment groups, ah, or whatever. But the problem is the focus on a narrow constituency and trying to find a decision which will appease the most vocal constituency, rather than looking at a, a more global group across the broader community.

JS: So just more generally, speaking from your experience, how often does the decisions depart from the policy?

CD: Regularly. Yeah. I mean, the policymaker will always deserve the right to make the decision, taking account of the, the various pressures and influences that they have. The role of the scientist really is to provide the information for them to make an informed decision. Once they make an informed decision then they'll be fully aware of the consequences of their decision. Ah, I think it'll be very difficult to get to a situation where policymakers will automatically accept the advice of the scientists and to implement it on its face value, without taking into account other perspectives, but not the science perspectives.

EF. *At the time of interview, EF was the director of a major Regional Fisheries Management Organisation (RFMO).*

How do you define the science-policy gap?
EF. … So to me science is a sort of systematic, a systematic accrual and a systematic formulation of knowledge. I think on the other hand, you know policy is rather, if you like, in some cases practically based, but it's normally the practice of statecraft, outlining the course of action.

EF. Now that doesn't mean that that course of action cannot be systematic and formulated; it just means that it is differ-, there are different drivers, one believes that science is essentially being done, if you will, to advance the state of knowledge. Ah, policy is being done to carry out, or to achieve some target, some identified course of action, in other words.

EF. So I think that that's an important distinction because when you come to talk about the science-policy gap, what you're saying is that, that in my view is that science actually, is possibly more rational in its outcome base than policy might be. Policy is interpretive in its outcome base.

EF. And there's a slight difference, and you can argue the semantics of interpretation and rationality but, and I think, what a lot of where that gap arises is plainly and simply the expectations are completely different. In science, the expectation is that even the wrong answer is useable, if it's been obtained in a systematic, rigorous formulated way, because it tells you something.

EF. Policy is not looking for wrong answers. Policy is looking for the best option. Whatever that might be. And it might be a completely, off the wall kind of thing, but it's the best option. So very often, when you look at this gap, there's a bit of incredulity on the scientists' part when the science says, 'Well it's obvious from the scientific point of view, this is the, this is where you end up if you follow this rationale, if you follow this reasoning'. From the policy point of view, the answer is, 'Well I don't wanna end up there, I wanna end up here, I want you to give me the information that gets me there'.

For you, what is the main cause of the science-policy gap?
EF. A scientist will say about a policy decision that it's generally not in the interests of the science. What do they say about that? Well actually, you can't expect that outcome; you couldn't expect that outcome because you hadn't taken cognisance of the best, of the science, what the science is telling you. So you know, well that's your fault.

EF. And the policy, if you like, practitioner, will say, 'Well I've had all of these things, I have had these outcomes in mind, or these practicalities in mind, you haven't given me the equipment. I have to pick and choose between those, and you know, you set me up to fail. Irrespective of what the science may or may not say'. Or, 'You haven't given me enough insight into the science for me to have set up this practical outcome, on the basis of the fact that I don't understand what you're saying to me. So it's a misunderstanding here; it's not my fault. It's your fault for not telling me properly'. So this, then it becomes a blame game. It's plainly and simply a blame game. The politician says, 'Well that's what the scientist told me, they know what they're doing', the scientist says 'Well politicians, what do you expect, they don't know what they're doing'. And I call a politician a practitioner of policy. Doesn't matter, it's not necessarily party based politics or whatever; it's government, an act, a practitioner of policy.

How do you see the science-policy gap operating in practice?
[See above]

Which real world situation can you give as an example?
EF. Ok, let us say, say we've got a fish stock that has attached to it; it has a whole lot of socio-economic drivers attached to it. It provides for jobs, it provides for food security, it provides for support industry, it supplies, might even in fact supply for government stability, if you look at a country like Namibia where a large amount of its gross national product comes from fisheries resources. So the scientist, so the expectation really is on policy side is that, to the scientist is, 'Give me the comfort to be able to operate and keep all these other balls in the air. All these things that really affect me as a scientist, I want my people to be, have jobs, I want them to have, have food security, and I want them to support me politically, and I want the country to prosper'. Now, these are all very good policy, or political decisions if one will, turn to the scientists and say, 'Well you five give me the science that justifies continuing fishing that supports all of us.' And the scientist comes back and says, 'Well on the basis of the fact', and gives a lot of qualifications, and says, 'Look, on the basis of the fact that the stock has had a bad year because there's global warming in the thing', the scientist says, 'You've gotta halve your stock. Gonna have to halve your catch'. And the politician will say, 'Well, how good's the science?' and the scientist will immediately qualify.

EF. That's, and this is a real case in practice. The scientist will immediately say, 'Well it's not really that good because I haven't had an independent stock assessment, the fishery is not reporting, we've got an ah, illegal fishery going on here, we don't know how much it is, ah we know people are catching undersized fish, and we're not getting those, we've had a bad spawning year, so we've got all these uncertainties on us. So this is the best I can give you at this time.' And that basically demonstrates a case in point. Because then someone has to take a punt. It's nothing more than a punt. And the politicians will always punt on the side of basically maintaining a status quo or improving a status quo. And that goes to job creation, food security, and revenue, really. And that's a realm that's very often time-based, and it only operates over four or five years, which is the elected period of office of most political players. The scientist will say, 'Well if I had that much more information, I had this more time, that will all qualify, but I will take, I cannot do anymore harm to this system if I adopt a conservatory approach to it, ok.'

What main socio-political tensions do you think are behind the science-policy gap?
EF. In terms of political, socio-political tensions, again I think it goes back to the question of expectation. Again I sort of approach it from a fisheries angle, but you could approach it from a large number of others. There's an expectation that if you are on the outside looking in, science is used as a tool to block you from actually doing something. So for example, if you want to start fishing, and you're a coastal state, and you want to start fishing, you've never had an opportunity because you've never had infrastructure or something, or whatever.

EF. Like Namibia there, you wanted to join the fishery, you couldn't, the science was saying to you 'there isn't enough to go around'. The people that have historically been involved in the fishery are saying to you in terms of policy, we are now in a position we can't give up what we've got because we've got all this other baggage, this socio-economic baggage that we're carrying along with our highly-developed industry. 'Sorry guys, you're not going to be able to do anything about this'.
So you get a lot of, certainly a lot of the more recent fisheries instruments to try to deal with this, like deal with you know, recognising the needs of developing states to have the capacity and whatever to understand the science, do the science, to have access to actually have the fishing fleets built for them and this kind of stuff.

EF. So, it's there, but it's there in lip service in many ways only, so that's the first barrier you've gotta get over. And there's a lot of argument going on now in the fisheries world, for example on certification, on trade certification procedures, because what they're saying is well, you know, trade certification of products, or designations of status of stocks or so on is only being done in whatever way to keep the developed countries out. And science, because it costs money, because it requires a high level of education, and very often a high infrastructure cost in some cases, it's seen; it's often used as a tool in a socio-political tension. And if you start getting into the realms of technology, it's even worse.

How do the decision-makers fit into the play between science, policymakers, and the science-policy gap?
EF. The one factor, and it deals with all the others, is that the one factor that I haven't actually alluded to, is the question of management of risk. Its, and what has evolved I think, particularly in some of the resource sciences map, let's not have this discussion. Let's not have this gap between science and policy. Let the scientist provide on the basis of their insight and knowledge. Let the science provide a set of uncertainties, and the risks attached to those uncertainties, and let the decision-maker, now you can see why I wanted to make that division.

EF. Let the decision-maker then be responsible for following one of those scenarios, or whatever it is, and let the decision-maker take the risk, rather than the science. Now this allows the scientist the comfort of knowing that, what they can, what the scientist is doing is nothing more than really taking the knowledge that is available and systematically applying alternative hypotheses or ideas to it, and providing some measure of outcome that has a risk attachment or a probability attachment to it.

EF. This, and that probability can be drawn on any number of uncertainty of knowledge, uncertainty of information, uncertainty of analysis, systematic uncertainty which is general if you like, natural variation or whatever. And that leaves a decision-maker in a far more difficult position, insofar that the other guy's taking a risk. So it does away with a lot of the policy gap stuff. Simplistic though it is, it doesn't cover the situations where the science if you like, the scientific, the outcome of the science is actually not that clear, in terms of pre-empting a decision to continue.

EF. …But at the moment, there's still uncertainty and I mean, even someone like, like Al Gore will actually say there's certain things we don't know, but he'll say it in a way that says, 'We don't know them' but he'll take the conservative science route.

EF. We don't know them, then do nothing, you know? Or at best, crank back so you don't make that a problem, hold back from it so you don't make it a problem. So I think that the decision-maker is beginning to have a much more responsible, I think, role where the decision-maker is beginning to now say, 'Well I'm serving two masters', because a decision-maker ultimately does serve two masters because a decision-maker is a person who should be the best synthesizer for the information both on the, on both sides of the gap.

EF. Because they should be best informed on what the science isn't telling them, and they should be best informed on what the socio-economical political requirements are of that, are to allow them to formulate a well-informed decision.

What is the dominant culture in marine resource management and how does this affect the science-policy gap?
EF. Well, the dominant culture in marine resource management is an interesting one. I mean, as I said, I like these questions, and you know, hopefully hopefully through some of the incoherency I've given you a theme, which hopefully is logical. I've always viewed fishing, which is really the centre of marine resource exploitation. One can argue that there are other things, mining, deep sea mining, and that kind of thing, which you've already seen manifestations of with respect to marine resource exploitation, living resource exploitation. That's the preserve of the coastal states, and it's only when there's any surplus determined by the coastal state that anyone else gets a look in. So you know, I think the dominant culture in resource management is that it's a common resource and, on the high season in particular, but even there, there's a local common due that it's, you know, the seas are bountiful, the seas are inexhaustible, the resources of the sea. It's my right to fish them. And therefore, it's far, in my view, if there's a continuum; it's on the exploitation side of the continuum.

EF. And I also have a, well; I mean I've spoken to a lot of fisher folk about it as well. I have a very strong view that fisheries are essentially a blood sport.

EF. You know, maybe it's a legacy of the hunter-gatherer or whatever, but it's very much a sport, very much an industry that's based on a very deep-seated psychological perception in humanity. You only need to look at a child with a piece of string and a spark plug, and if there's a puddle in the road they'll throw it in and they'll go fishing. They'll play fishing. It's that primal. And that is also exploitative, absolutely.

EF. So I do see that the dominant culture in marine resource management is there's always more fish out there. I'm not going to catch the last fish. There's always something else, and if I don't get there first, someone else is going to take what's rightfully mine. And that's a really, really difficult cultural gap. And that means that, I mean I'll go right back to the beginning; scientists are very very often bad politicians. You will not see scientists lobbying a minister or lobbying a decision-maker in the same way as you'll see a fisherman doing it. They just don't do it; it's not in their nature to do it. Look, it does happen, and there are always exceptions to the rule, but if there's an issue, and one can say, 'Well, the scientist is far more abstract in dealing with their interests than someone who is making money from that interest directly'.

EF. So, you know, the culture in marine resource management is generally, I think, and that goes to a lot of decision-makers, and I'm not saying that the decision-makers in marine resource management are bad people; the pressures are that they are very often put into the position where they can only make a decision in the support of a continued exploitation, where everything is telling them, that that's not the way to go. And they're overwhelmed by the, as I said, we're going back in the beginning, by that, all that baggage. By the fact that their jobs and their future security and all these other things, these immediate, absolutely immediate needs attached to that decision that they're going to make. And it takes a very very brave decision-maker to stand up and say, 'right, I'm cutting this', or else a very very serious situation, and neither of them are, you know, it shouldn't be that in either case. I'm going to have to stop fishing all this. I'm going to have to cut it by half, I'm going to have to cut it by three quarters, or else there's going to be nothing left. And very often it's left to slide. And you know, you see it.

EF. You see it in every single situation. You will see generally the hard decisions slide. And every now and again a good, a hard decision will be taken, but in most cases, not. And I think it's just purely and utterly this, and one can put it, if you want a sound byte at the end of it, fish don't feel, you know. There's this perception, the fish doesn't care, why should I?

GH. *At the time of interview, GH was the director of a major Australian Commonwealth science research and policy organisation with an ocean science focus.*

How do you define the science-policy gap?
GH. I mean you can look at it two ways, there are two kinds of gaps really; one is whether the science informs policy, and in order for that to happen, the science has to be in a form, or I suppose understood to have a, to have a policy context. So you can do a whole bunch of science that never enters policy, that wouldn't really be a science-policy gap because it's not relevant to policy at all, there's, for instance there's probably very little of cosmology for instance that's policy related; when you get down to something like natural resource management, fisheries, or conservation, then you, there's a whole bunch of science that might be relevant to policy. Now, the gap can exist for two reasons.

GH. One is that the science doesn't exist; in other words there's no science that can help fill a policy, that it can inform policy or help fill a policy gap. Or there's plenty of science there, but it's not in a form that's accessible to policymakers. So there's two, two holes in that direction; one is the existence or otherwise of relevant science, and the other one is the existence or otherwise in science that's in a form that's understandable by policymakers. Now on the other side of the fence, the gap could be that policy is made either actively or, or unconsciously in the absence of science, so that the people make policy decisions without bothering to take into account, without even bothering to understand whether there's any science that might be relevant to them, or actively not taking the science into account because there are other policy imperatives or perceived policy imperatives that override the fact that science might exist.

For you, what is the main cause of the science-policy gap?
GH. There are two. One is, 'Oh, well science doesn't give me the right answer, so I don't, I don't wanna take any notice of it'. And in that for instance, has been the history of many fisheries around the world. So there's that kind of, that kind of science-policy gap. Or the other, which is usually more common, is that scientis-, that policymakers don't understand what science is actually telling them, and scientists can't actually convey to the policymakers what it is that the science is telling them. And that's a, that's sort of that's really a communications issue. The science might be there, but it's not being, it's not being passed through or presented in a way that makes it relevant to the people that are making policy.

How do you see the science-policy gap operating in practice?
GH. … in the fisheries area, ah well I think that it's really hard for policymakers to understand what, what the scientists mean when they say, 'Well the total allowable catch or the total sustained yield for this population is a figure somewhere between, let's say three tonnes and eleven and a half tonnes'. 'Well, you know, why can't you just give me a number?' 'Well I can't give you a number because the statistics show that that's the range of figures that you get every time you run the models of it. Somewhere between three and eleven tonnes.' And then that's, that's also treated as being well, 'Why can't they give me a better answer that that, so let's pick a number right in the middle'.

GH. And so trying to turn that into something that makes sense to a policymaker, and saying, 'Well ok, if you take the upper band of that estimation, you are being less precautionary than if you take the lower band.' Trying to, trying to put those kinds of scientific predictions in words is really hard. So a part of filling the science-policy gap is having that kind of conversation so people understand; it's a bit like people have to understand what the likely impact of their decision is if they ah, if they make a decision on one set of figures, as opposed to a decision on the others. So getting, ah getting policymakers to understand that everything isn't black and white, is probably one of the hardest parts of that discussion.

Which real world situation can you give as an example?
GH. Well look, put it this way; I think its taken people, in climate science, for instance, or do you want me to go do one directly related to fisheries? But in climate science for instance, I think its taken people a long time, its taken policymakers a long time to understand that when scientists were being cautious about the predictions for climate change, they weren't actually saying that climate change wasn't happening.

GH. I think that's a classic really. I think policymakers often take the very cautious prediction of scientists, as being, um, doubt, and often because you know, policymakers are usually wanting to make reasonably quick decisions, and they are usually wanting to have a series of facts with a capital F to back them up. And the reluctance of scientists to say, 'Well here's a fact that you can use to help your argument', is often misinterpreted as the scientist being doubtful and unsure of their own evidence.

What main socio-political tensions do you think are behind the science-policy gap?
GH. Aach, yeah I'm not sure that in a lot of cases, I mean I suppose it's social more than political, I mean, in a sense policymakers like to feel sure that their, that their decisions have a reasonable certainty of doing what they, what they're supposed to do. And in that sense, they're less likely to be, they're less likely to understand ambiguity. They'll want a figure, and they'll wanna base a judgement around that figure. Now, I suppose one of the things, say in the CCAMLR system, that's worked really well as a concept of precaution, whereas you can say, in the CCAMLR decision-making framework, you can say 'well, here's what the science tells us, but there's a fair bit of doubt around that, so in order to be precautionary, we should set a figure at least below this one.

GH. That doesn't happen in very many other organisations. You look at Southern Blue Fin Tuna, or any of the other fisheries bodies, the whole political dynamic is to aim for the highest figure possible. And so you have, you actually have a very, a very different dialogue there; you're actually having a discussion about how to maximise your return, rather than minimise your impact. And so in that sense you got different cultures in different organisations.

How do the decision-makers fit into the play between science, policymakers, and the science-policy gap?
GH. … I wouldn't draw that distinction. I think policy's made at all different levels. I mean, you can have a, in a sense ultimately, a policymaker is somebody that makes a decision, that actually has an impact on what somebody else does. And, and I don't really see the difference between the decision-maker and the policymaker. There's a difference between a policy adviser and a decision-maker. But all policy advisers is doing is framing a set of arguments.

GH. See, if you think about it in terms of government, right? I mean, ultimately policy is made by government, not by bureaucrats. And bureaucrats are people that advise the government on the, on questions of policy, and say to other people, the chamber of commerce or the mining industry council or the ACTU; I mean there's a whole bunch of people that wanna play in that policy space, but ultimately it's governments that make the decision. Now if you take it down to the next level, I can make a policy here about ah, about the kinds of things that we might want to pursue, in the long-term in the xxx, now I can make that on my own, or the government can override me, and say 'ah no, we don't agree with that, we think you should be doing this that and the other'. So it's really hard I think, at the end of the day, to make that distinction between a policymaker and a decision-maker. A decision-maker is somebody, in my mind, if you want to take this the step further, a decision-maker is somebody that takes a piece of policy advice and makes a decision in the context of that advice. Rather than the other way around. … Very much a grey area. And a hard one to draw a boundary around, I would say.

What is the dominant culture in marine resource management and how does this affect the science-policy gap?
GH. Well this is, this is actually interesting. I think we're starting to move away from a dominant culture. But ah, not, not very far away. And not, ah, not very far, and not very long ago. But look, the dominant culture in marine resource management, and you're talking about marine resource management here, has been the tragedy of the commons, really.

GH. … you know the sea is all bountiful, and there's no, there's no limits to what you can take from the sea. It's been a long time since people have argued that, but the culture of access to marine living resources has been that of, of unfettered access to the high seas. And that translates itself into a whole bunch of behaviours, such as ah 'if we get in first with ours', in the absence of any internationally agreed mechanism for managing these resources, then no management is required. That all nations and all flags have the right to exploit the resources of the high seas, and that's meant that those that are interested in, in the very first instance, regulation, and then beyond that conservation, are always playing catch up to, to this sort of high seas rights mentality.

GH. And the high seas rights mentality is based on this idea that the resources of the sea are endlessly bountiful. And there's only been a few areas where that's been ah, for more than a few years has actually been challenged. And the CCAMLR convention's one of them, where the whole premise for, while it's still centred in international law, and acknowledges the law of the sea, and acknowledges the high seas rights of nations, it's still predicated on the fact that conservation is the primary goal of the convention itself. And that ah, and that ah there needs to be in place a set of decisions and rules that allow for the marine living resources to be managed.

IJ*. At the time of interview, IJ was the Australian Marine Project Leader for a major international conservation organisation and was working in oceanic fisheries.*

How do you define the science-policy gap?
IJ. Well I guess that the, the gap as I see it is the fact that you have, in many cases, now legislated or regulated, whether it be at the country level, regional or international level, structures that incorporate whether it be scientific advice, that is to be taken into account when management decisions, or if you like policy decisions are being taken, and how to manage, and in this case I take it we're talking about fisheries resources specifically...

IJ. … I would define, the gap is where, whether it be a binding process or a non-binding process, that science advice going into the policy or management decision framework is being ignored.

IJ. So there's a mismatch between, if science is saying, 'You need to reduce a TAC for a resource', and that doesn't come through in the decision-making process.

For you, what is the main cause of the science-policy gap?
IJ. Ah, that's a good question. I think the main cause is that there's a number of reasons. First would be that in many cases, it's a little bit like how national legislation considers stakeholder consultation; it's done on 'we will consider stakeholder advice', rather than 'it has to consider'.

IJ. And it's this whole problem, which I think is now a global problem within fisheries, which is about whether you take a non-binding or binding approach to decision-making. And more and more, within regional agreements, and particularly as they relate to bycatch or related species measures, they are put into non-binding arrangements within a convention, say, that for example, in an RFMO, quite often resolutions or decisions of the parties to a convention are non-binding, depending on the convention

IJ. So I think, back to the question about what's the cause of this gap, firstly it's this binding non-binding relationship; the other is that I think there's a lack of willingness, well there's a sense of moving towards a very well articulate, articulated management procedure framework, if you like, in some of these complex RFMOs, but in actual fact, which is meant to take away the political influence or decision-making, when you go from the science to policy bit, but no matter what, a lot of these conventions are either consensus agreements, or they're a majority by three quarters or whatever, and it's very difficult getting agreement, and that agreement is not a base about having a very clear procedure that's only based on the science, it's still about political will to do so.

How do you see the science-policy gap operating in practice?
IJ. Well I guess it's a little bit following on from what I just said; you know, if you look at any of the, again, national, regional, international agreements for fisheries, I think that there are discussion, I think there are very good scientific discussions about what current catch levels may represent, but then when you measure it at the end of the day, and this is what we did with the recent xxx report that we produced, to us it showed that well, you know, there is a general lack of accepting that advice. Also, if I look back, I've been participating in CCSBT, which is the Southern Bluefin Tuna Convention for fourteen years, and there has been all sorts of scientific advice go into that commission, which has not come through in management decisions, and in retrospect it was always that the stock assessments, well probably did reflect how poorly the stocks were behaving.

IJ. Yet despite that knowledge, the managers had still not changed TACs at all.

Which real world situation can you give as an example?
IJ. And to me again, CCSBTs a particularly good example of where, it's only in the last year that it's been, well two years, there's been changes to the TAC, which was predominantly based around the fact that science has been saying, 'Look, the stock's really in trouble', and secondly, that it was demonstrated that Japan had been catching twice the level of quota, legally, that/than it was allowed to. And they were basically put into a place where no longer they could just sit on the same TAC from year to year to year, ignoring scientific advice. But one has to remember; the change in that TAC was not based on scientific advice; it was based on the fact that Japan had been caught illegally fishing. And it still does not represent what you would measure in a management procedure sense, as going from the policy being directed by the scientific advice.

What main socio-political tensions do you think are behind the science-policy gap?
IJ. Oh, I think it's obviously that, you know, in the last ten years, if you look at the behaviour of the distant water fishing nations, I mean they've seen it, that there are conventions being created, which are very much like a giant pie, if you like. And if you don't quickly get in as a party to some of these conventions, then you're not going to get a slice of that pie. And so for me, it's, a lot of the political will about what's been happening, in the first case, it's about locking up resources so that they can ensure an allocation.

IJ. So I think there's, excuse me, that social political tension. The other issue is that, Western Central [Pacific] is a really good example of, if you look at the geographic area that's being fished, it's predominantly under the EEZs of the 22 South Pacific islands. And there's only a very small area in the middle that's high seas. And so the social political tensions if you like, is well, you've got science that says, 'Well look, Big Eye [tuna] and Yellowfin [tuna], we've got to do something about the overall mortality that's occurring in the fishery'. And then again, it comes down to an allocation issue. There has not been any allocations within that forum. And how do you account for the political and social issue of developing countries, where a lot of the fisheries within there are EEZs.

How do the decision-makers fit into the play between science, policymakers, and the science-policy gap?
IJ. I'm not sure I understand the question, cos to me the policymakers are the decision-makers. I think, I guess I'd interpret this question more to be about Australian national processes, rather than regional and international. How do the decision-makers... so you mean at the ministerial level then?

IJ. It's a good question, because one of the problems we've always had is that the level of ministerial discretion that's given is quite often too much. And for me a perfect example would be you develop legislation around particular policy, ok? So it might be you have decided that you will have an endangered species act. That allows for the nomination of whatever species. Now, nominations are made, and they might be fisheries, fish that are caught in fisheries. And then you have what's called an independent scientific committee that reviews the information into that. They make a recommendation that's considered by the department that is then put up to the minister.

IJ. And there's different levels at which precautionary principle needs to be considered, and it's interesting because in this case, the minister, the department, needs to consider the precautionary principle when providing advice to the minister on a listing proposal. But then the minister doesn't necessarily have to take that into account. So there's that level. The second part is that the fisheries, if you look at the scientific committee recommendations from EPBC, the advice from the department and then the ministers' decision, they don't link; there's a big gap.

IJ. And there's in my mind, too much discretion given to ministers to make those decisions, ok.

What is the dominant culture in marine resource management and how does this affect the science-policy gap?
IJ. I think there's been a change in the culture which affects the science-policy gap. I think there's a lot better and available information on the status of fish stocks, which a lot of it has really come about from the BRS reports, I don't think there's any ignoring that.

IJ. Which is one reason why we really want to see the states incorporated into these BRS reports, and much better cooperation between states and Commonwealth, so that the resource owners, who are the population of Australia, can see how their resources are being managed, so I think there's that, and I think that's had an enormous influence on the ability for ministers to just go ahead and manage according to how they would like and not be accountable. The other thing is that a number of policies that came in probably eight years ago, like the different oceans policy, bycatch policy etcetera, I think has really put on the table for a long period now, the direction that fisheries management has had to go in Australia.

IJ. And I should clarify; I don't, I think it's very easy to blame the actual commercial fishing industry for anything that's happened, and I don't, I don't see that they're a problem. I see the problem is that from the word go, when the Australian Fishing Authority changed to AFMA, it, it went on a long period of cooperation with industry, and what that meant actually, in my mind was that the hard decisions that had to be made about restricting either access or catches in fisheries weren't made because the partnership was too strong between the two, and there was a reluctance to make really hard decisions that were going to impact on industry. And so instead, what was done was, if you like, more like encouraging, putting in place certain controls on fisheries that should encourage unprofitability by some sectors in the industry, and therefore move out, get less effort in the fisheries. And it didn't work. And I think we're now in a stage where there's acceptance that we have to, it's no longer a God-given right to go out and fish. It has to be done in a certain way.

IJ. What I am concerned about though, at this very moment, we've got harvest strategy policy, we've got a number of efforts on ecological risk assessment, and therefore how you move that into ecological risk management for fisheries, but a lot of the communications that now again are coming out from AFMA, is all based around partnering with industry to make sure there's least impact on industry, and if anything else, there's growth in the industry. Instead of us hearing the statement that AFMA is there to manage the resource, we are getting communications coming out of AFMA that it's, that AFMA is all about protecting the industry. And I'm really concerned about that at this stage, and wonder whether we're about to see a change in culture, or whether it more reflects, the, if it more reflects the senior management of AFMA, and how they want to deal with it. Because it seems a gap between what we're being told at a policy level, and what we're being told by senior management within AFMA.

KL. *At the time of interview, KL was the Executive Director of a major Australian fisheries industry organisation.*

How do you define the science-policy gap?
KL. I'd basically define the policy gap from the position that the policymakers are not giving clear direction through tight strategy about what they need done to inform policy.

KL. And quite often when they then des... can give clear direction, they don't clearly link the activities that are going to be undertaken by the scientists, through the process to ensure they're going to then, meet the needs of the policy people. So they basically ask a broad question of the scientists,

KL. And then expect that the scientists will do it in a way that will give the results to solve the policy issue. So there's not a clear logic, pathway between the research all the way up to being used in the policy, delivering outcomes at the end of the day.

For you, what is the main cause of the science-policy gap?
KL. … several main causes. One is that basically that the policymakers, and err including industry, are not clear about what they want. So they haven't developed good strategy, tight strategy.

KL. They then don't work effectively to develop a logic pathway, from the research or the activities, all the way through outputs to next users to outcomes; to ensure that they test what they're going to do is going to work. So from that side, it rests with the policymakers. So they're unclear about exactly what they want, and then they don't test to make sure that what's delivered by the scientists is going to meet their needs. And then the philosophical blockage within the scientists, you generally wanna do the science they wanna do. So even when the policymakers are quite clear, the scientists want to go off on their tangent, that they want to answer.

How do you see the science-policy gap operating in practice?
KL. The reality is the policymakers need to put a lot more effort into their planning. With stakeholders, they need to work out what they need in regard to their fisheries, where they want their fisheries to go.

KL. And therefore how they're going to get there. Now that needs to be not motherhoody, it needs to be very tight. You might have a longer-term view, which is probably a twenty, ten to twenty year view that can, that has to obviously be a bit hazier, because it's looking at... a long way, and the further out you go, the hazier it's gonna get. Then when you get down to about the four year level, you had to be very tight. You need to know quite clearly where you're going to go and how you're going to get there, and that then needs to inform your investment into science.

KL. We get to the stage where we know, where the policymakers know what they want, they need to then sit down with the scientists and the stakeholders and work out exactly what pieces of work they need to do to get there.

Which real world situation can you give as an example?
[Not answered directly]

What main socio-political tensions do you think are behind the science-policy gap?
KL. It's this real, what's the way to put it? A couple of things, one is that scientists for many many years, particularly government scientists who are paid just to do science, they got to choose pretty much what they want to do; they knew they had a wage so they knew they had an operational income, and they just went and did what they want to do. That changed in the 90s, well probably the late 80s, but particularly the 90s and is no longer the case, we've got a very much, purchaser and provider system at the moment, or an investor-deliverer system if you want to use a bit of language. Ah, then you've also got your academic researchers who of course operate in different spheres of government scientists, it's more about base research and a bit more academic freedom. So sometimes you've got the difference in between trying to get them to do a bit of the targeted research as opposed to more basic research. So we're trying to swing the scientists around to say, well actually you've got to do the work we need done to deliver the policy.

KL. And you've got the policy people who are used to being very ah... ad hoc in their processes. And very reactive and not very planned. So we need to actually get the policy people into the very planned position, do the front-end work but also be bound by that into the future. So where you've got your tensions in that process, is that past philosophical positions in regard to both groups about how they do business, and both have to realise there's gotta be a lot more structured, with a lot more front-end agreements about what's going to be done and then a lot more rigour around the delivery process at the end of the day.

How do the decision-makers fit into the play between science, policymakers, and the science-policy gap?
KL. Well... that's part of your next users. So as you work up through your process, your science will produce outputs which are reports, or data, or something else. And your next users, they may be a fisheries manager, it may be a fisheries director, it may be a minister, it may be a secretary. So when we go to the next users, we need to make sure that what we're delivering is what they need to make the decision they wanna make that becomes into practice change. So practice change in regard to, ah, a minister, may be, the practice change may be a change in government policy that will then deliver the industry outcome that you want.

KL. As you work up from resources to functions, activities to outputs to users, your outputs from your science may be a report, that will then go to the minister whose next duties is the practice change after that will be a changed policy, or an induction policy position, which will then deliver the outcome which is the next level up, which is what you want to happen for the industry.

KL. You've gotta consider that all the way through in your pre-planning; what will they want, and that may be particularly if you've got a ministerial decision, you want to engage with his office at the front end of the day, make sure that you've listened to and are aware of his concerns and considerations, so you can give the information to resolve those, those concerns or considerations.

KL. The ministers either have a statutory decision under the legislation, or they create policy.
So basically, it depends on the decisions… will be based around stock assessment work.

KL. But also economic, and social, ahh performance indicators with industry. So you can harvest close to the limit, but your recovery will be longer, but the industry might want a quicker recovery. So you need to put all those into the mix and then give ... so he can make a decision about it all. What the total allowable catch is. But it may be said in the policy position in regard to the regulation of an industry.

What is the dominant culture in marine resource management and how does this affect the science-policy gap?
[Not directly answered]

MN. *At the time of interview, MN had recently moved on from working as a senior manager in a major Australian fisheries management organisation.*

How do you define the science-policy gap?
MN.… is the gap between, say the outcome and recommendations of marine research and the actual policy objectives or the final decisions, so by the managers or the policy agencies, so and there's two issues there, I guess is 'what is the policy' and the other one is 'what is the level of alignment between policy and the final decision'. And so I'd see the gap as being primarily the gap between the outcomes of say research, ample fisheries research and the final decisions, made in relation to that research. So there's two; I guess it's important to understand, you know for my purpose at least, is that there's two elements to policy. There's the policy itself and then there's the final management decisions that are made, you know to pursue the policy. And there's obviously at times some divergence between the actual decisions and the policy objectives.

For you, what is the main cause of the science-policy gap?
MN. I'm sure there's others but one I think is a lack of clear policy objectives so, you know, it's very hard to have a tight connection between the science and the subsequent policy or decision-making if the objectives of policy or management are not particularly clear. So that I see in my experience as one key area. Another one is the nature of politics and electoral cycles and governance and the reluctance in the context of that for hard natural resource management decisions.

MN. Those decisions often have a direct negative impact on business, and often have a direct negative impact on other stakeholders, say in the case of marine parks for instance, you know there might be... are we clear that certain areas should be closed up for conservation but the consequences of that on either business or tourism or other human use is negative, so that then makes it more contentious from a political perspective and I think that whole connection of political cycles and politics being, you know, the pursuit of voter satisfaction on a mass scale is one of the things that means that the final decisions are not always closely aligned with the recommendations from research.

MN. Another one, Jon, is that and I think this has left the case these days and perhaps in the recent past is that, that question of what is driving the science or the research, and is the research or science being clearly driven by management information needs or policy needs or government needs, or is it being driven more by the science or the researchers themselves, thinking about what they think is important, and what directions they think research should be going in, so sometimes in my experience there's a gap between, you know the directions that research is heading in and the actual management needs, and that can be either a philosophical issue, or it could be a lack of awareness on the part of decision-makers about what the policy objectives should be.

How do you see the science-policy gap operating in practice?
MN.… so one of the areas where I've seen it, and I guess it still exists in my experience, is in say an international fisheries management context.

MN. Where there may well be some pretty good science available to guide decisions on global TACs for instance. But the sheer difficulty in getting international agreement to a catch level is a sort of a really good example of, at a macro level, of a gap in action, I guess.

MN. And it's the sort of issues we deal with domestically, the issues are very similar in that you've got a bunch of interested parties or stakeholders and they have divergent objectives. And as a scientist or a manager, you've got to try and reconcile science with various objectives and come up with an agreed way forward. And that's just so much more difficult in an international environment. So I guess for me, the international management arena is probably, you know, certainly not the last frontier, but it's one of the most challenging environments in which to test that science-policy gap, if you like

Which real world situation can you give as an example?
MN: Yeah, although certainly in certain decisions, you know, one sector will hold sway over another, kind of thing, and again, that's very influenced, I think, by the government of the day and what they're sort of either clear or less clear policy objectives are.

JS: Yeah, and when you say policy directives, are you saying actual clearly enunciated ones, or more we're for business?

MN: Well both, and obviously they're not always clearly enunciated, they might be enunciated in the legislation pretty clearly, but even within that, there's quite a lot of scope for variance in decisions.

MN. I don't have enough exposure if you like at the really high level to know about you know, the sort of written versus unwritten policy objectives. But certainly I know that at certain times, you know there is a divergence from you know the black and white interpretation of legislation.

JS: Mmm, yeah that's often for political reasons.

MN: Yeah, and that depends on the, you know, like you know, like the period before an election's always an interesting one, cos there are definitely, you know, pressures and priorities that are not, always as they appear in black and white, kinda thing, you know.

JS: Yeah, it's not as if the public service, doing its regular job is responding to um... I was talking to one person who said that they, ah respond to the desires of the Government, as you were saying.

MN: Yeah, at times very much. At times that can be incredibly powerful. And that's you know, what I was saying earlier, I guess that's one of the key reasons for a gap.

What main socio-political tensions do you think are behind the science-policy gap?
MN. I guess you know it comes back to some of that earlier stuff but for me, there is a focus on the short-term objectives, whether they're political objectives or business objectives, so I think that definitely confounds the uptake of research if you like, and in the setting of, in a fisheries example, might be much better to set a conservative TAC and have a long-term income stream from the fishery, but that's going to happen over several electoral cycles, or several, or during the tenure of several different business managers or whatever, so it's that sort of short-term approach and I think the electoral part of it is significant, in that there's, you know in a classical sense there's only a short period of a year in any one electoral cycle where decision-makers are really willing and able to make difficult, longer term decisions.

MN. And you know, when the election's coming up and things become I guess a bit more short-term focused, and more about influencing voters in different electorates, and that sort of thing. So I think and just that sort of here and now economic pressure on business and you know, as a manager, or an ex-manager now, but you know, just the fact that in most bureaucracies, certainly within politics, there's nearly always much greater attention and focus on short-term pressures and short-term objectives and the expense of longer term strategies.

How do the decision-makers fit into the play between science, policymakers, and the science-policy gap?
MN. I think you know, there's obviously it can go several different ways, and the best way is that they provide an element of clarity in terms of objectives which then flows through into clearly targeted research and research outcomes that are clearly relevant to the management objectives. And I think decision-makers have a key role in ensuring that alignment, both in the commissioning of research and also in terms of their own understanding of their management in environment and the information gaps. And the less alignment there is, the more scope there is for the gap, if you like. There's also I think a bit of a, in terms of just defining decision-makers versus policymakers, so in say the AFMA example there's, you might see AFMA as the operational fisheries management decision-makers, setting TACs and implementing closures and that sort of thing, and policymakers are more at the department, you know, the DAF level, and say the inner more political environment.

What is the dominant culture in marine resource management and how does this affect the science-policy gap?
MN. I think one of the key cultural issues or, it might even be a technical issue, is how do you, literally how do you manage in the face of scientific uncertainty, so there's in some cases an expectation that science will give clear answers to a problem, and it often doesn't. So, and there's a reluctance, I think there's a bit of a culture in the bureaucracy of 'if there's no clear answer, we won't make a decision, or we'll you know defer a decision, or we'll seek more information'. So that sort of managing in the face of uncertainty, particularly in the context of natural systems or fisheries ... real issue, and there's, you know, obviously things like the precautionary principle that were developed and enshrined to deal with that, but you know, being with limited kind of uptake I think, in actual fact. You know, there's some examples of it, but again it gets confounded by political cycles and pressures on bureaucracies and that sort of thing.

MN. But I also think, you know, I guess its all very well for decision-makers, and so they deal with uncertainty all the time, but I don't see a lot of examples where that precautionary approach is adopted fairly, fairly clearly, you know. It's something that's very difficult to deal with, you know. If you're making a decision that's gonna have an impact on you know, a lot of people or a lot of businesses, and there's no evidence, no real clear evidence one way or the other about whether you should do that or not, then it's a difficult decision to make.

MN. So I think there's that pure element of it, if you like, and there's also that more the sort of lobbying part of it where lobbyists will certainly use uncertainty as a reason to delay decisions or seek more information and that sort of thing.

OP. *At the time of interview, OP was a senior marine campaigner for a major Australian conservation organisation.*

How do you define the science-policy gap?
OP. … here in Australia is that at times policy may head up, I suppose institutional arrangements, planning processes, etcetera, which require a significant amount of marine science research, public good research to actually be able to provide the data and the knowledge to make really well-grounded decisions.

OP. Often policy is, you know, the policy may not be that strong, it probably tends to suggest an outcome which cannot be achieved without really significant increases in resources going into finding out more about the marine environment. So I think probably in terms of the gap, it's basically where policy expects an outcome, but it can't be achieved because there is insufficient resources going into the science.

OP. And I guess it's also reflective, this whole science policy gap is that policy by driving a particular outcome, but it also sucks in scientists, and they aren't able to provide really strong, independent public comment.

For you, what is the main cause of the science-policy gap?
[See above]

How do you see the science-policy gap operating in practice?
OP. Well I suppose I sort of touched on it a little bit, but basically if you look at something like the national representative system of marine protected areas, the RSMPA, Australia's supposed to establish an interim RSMPA by, well it's supposed to be by 2012, to establish a comprehensive, adequate and representative system under the current rate, we'd be looking at somewhere probably in the middle of the century before we actually do that. And so, this is a policy which has been generated at international arrangements as well, but it's also a policy which has been adopted by Australia's government, and also by state governments.

OP. But the policy is there, and they actually have to get out there and do it.

OP. Now, if the science isn't there, you end up getting what I'd probably consider what I'd consider being paper parks, where we have lines on maps which suggest that we, yes, we've actually done that, we've put a line on the map, we've actually got a park there. But it may not actually be in the right place, may not be enough of them, it may not have sufficient protection, you might get multi-zoned MPAs, which are sort of the flavour of the month here in Australia; we really need to be focussing very heavily on no take, but the difficulty is that when you have a policy to establish the robust system and you don't have the science, it's actually, in terms of conservation groups who rely on science to be able to argue their case, it's very hard to argue that case.

OP. And so that means that industry stakeholders have a much greater influence over the result because they have their own research, they can actually put that on the table when they want to. We've never really, the cognisance of what that research actually is, and so again, if we had a much stronger public good research sector, particularly in the southern part of our oceans, then I think we, we would be able to get a better result in terms of marine protection.

OP. But the environment sector is somewhat hamstrung, because they just don't have the available information. And the thing is, industry has limited information too, and uh, there needs to be a concerted effort in trying to breach the gap, by substantially increasing the amount of resources going into marine science.

Which real world situation can you give as an example?
OP. Well, I've probably spoken about the issues with the RSMPA. Well I suppose, it even comes down to fisheries management, we're trying to, in Australia we've been trying to establish ecosystems based fisheries management, and I said that was being a bit of an oxymoron because I think basically to be ecosystem based management, you've gotta be integrated across all users of the marine environment, it's not just about fisheries.

OP. So if you establish an ecosystem based fisheries management model, it may not actually take into account the up uses and so that doesn't help if you're trying to establish, trying to manage interaction with the environment, which is what ecosystems based management is all about. It's not about manipulating the environment which some people would like to do, and do. So there is, a problem there also, that we, again, we don't have enough knowledge, although there is quite a bit of work being done by CSIRO now, but I'm not really across, at the moment they're doing a bit of work on ecosystem based management, but what happened with oceans policy, which said, look we need ecosystem based management, we need integrated planning, was that in the end governments decided to throw up their hands but we just can't work out what this ecosystem based management is.

OP. The reason being, they didn't have the science to back it, they didn't have the will to actually do work. And so we've got this situation where everyone knows we've gotta, we've gotta implement this sort of program, and there's other people in other parts of the world trying to do it as well, but we're just not getting efficient scientific knowledge to give us the ammunition to be able to get [what] we need to know about the ocean there to be able to do ecosystem based management, which is basically spatial management.

OP. And oceans policy had that as a core of; at the core of the policy was ecosystem based integrated regimen planning. We haven't got there yet, but it becomes strategic plans rather than spatial plans. They become pretty much plans for plans, not really genuine outcomes. And again it comes back to, one is science knowledge we don't have, but also there's a real problem with scientists and science being denigrated by other stakeholders.

OP. And that another issue as well as, if we had graduate investment, then scientists would have a much stronger position within the whole sort of dynamic of oceans planning, protection and management, but because they'd been well under funded, because they've had to then sort of engage with industry, in industry projects it starts to sort of create some real problems, like where is the supply of independent scientists?

OP. Australia's got a fairly small pool of marine ecologists, marine scientists, fisheries scientists and so on, and when you lose those to government and to industry, it's very hard then to be able to project strong I suppose community-driven sort of science program. And so groups like AMSA become quite important, but again, a lot of their members are also getting caught up with other processes, and it makes it very hard for them to give really sort of, vigorous robust advice.

What main socio-political tensions do you think are behind the science-policy gap?
OP. I've probably alluded to a couple of those I think, but my view, and the view of a lot of others in the environment sector that, and probably across other sectors as well is that scientists are credible messengers. They really, the community does respect what scientists do, and they listen to scientists, I think they get a bit confused at times when there are scientists arguing a different point, especially in the case of climate change, but generally they regard scientists as being those people who can actually give good, rigorous advice. Now, in terms of the socio political tensions, ah as I said, there has been an attempt by some stakeholders to denigrate the role of science.

OP. For very many reasons, particularly the price of oil, etcetera, the need to find transition fuel between coal and renewables, gas is obviously that transitional fuel, so there's an awful lot of pressure on governments, from a tax point of view, they get a lot of money out of it, but also from a economic development point of view, to provide an awful lot of access to the oceans for the oil and gas industry, so when you look at the most recent release of acreage to which has happened just in the last week, virtually all of Western Australian waters and Commonwealth waters of Western Australia are pretty much covered in some form or another by acreage release or leases or whatever.

OP. Now when you, when you get a situation where before you do any planning, you've pretty much allocated the oceans to a particular industry, it creates enormous problems in terms of socio-political tensions which you refer to here, because if you try to find a no take, an area to establish a no take protected area, where do you do it when every bit of water has actually been allocated to the oil and gas industry, if you regard the oil and gas industry as an extractive industry, which it is, it removes stuff from the sea bed, from under the sea bed, and there's obviously environmental issues in the water column, and in terms of the environment where they actually establish their infrastructure, and so the North-West Shelf's, Scott's Reef, all those sorts of areas, there are some major tensions which are going to develop over the next year or two, because the Kimberley coast, the area off the North-West Shelf has become the focus of everybody's attention. And that's where there's gonna be enormous tensions about how do we actually create an effective network of no-take, or any protected areas, when all the water is pretty much allocated to one industry?

OP. Ah, even, and there's obviously tensions between the fishing industry and the oil and gas industry in terms of just the use of the oceans, and there's clearly tensions between oil and gas, fisheries and the environment sector, and in the case of the Kimberley, Indigenous communities as well. So there's a very potent mix in terms of those socio-political tensions. And so all those sorts of tensions, I suppose, work around that science tends to get caught up in all of that, so any scientist, any decisions to fund science are going to be very much couched in the way that socio-political tension works out. And in the past, the oil and gas industry and the fishing industry have been able to dominate the outcomes in terms of that tension, and it means that policy and sci-… I guess the gap between science and policy has broadened I guess from our point of view, because we want to have, and I guess it also comes down to what policy we would like. I mean, our policies, whether it's ACF or WWF or AMCS or whatever, our policies are usually out there beyond where government wants to be.

OP. And so we would see the gap as even wider than what governments and others might see the science policy gap as being. So, cos the policies that we would like to see in place do require a considerable amount of science to be able to; but there's also the issue I suppose of precaution. And ah, and that's the other issue that; the precautionary principle's *unfunded* basically, but it does indicate that ok, if you haven't got the science, if you haven't got all the knowledge, you need to be precautionary about your decisions. Unfortunately, that precautionary principle isn't always being followed, in terms of decisions being made around policy. So even though there might be a gap, but in some ways you can bridge that gap by being precautionary.

How do the decision-makers fit into the play between science, policymakers, and the science-policy gap?

OP. … if we're talking in terms of government decision-makers, rather than decision-makers within industry and so on, ah policymakers are also governments too, to some extent. Ah, pretty much decision-makers are under a great deal of influence, by whoever's got the whip hand of influence. So in terms of oceans, planning, protection and management, it's been largely the oil and gas industry and the fishing industry. And they have very strong support from their respective government departments, whether it's in Commonwealth, where you've got the Industry portfolio or the Fishing portfolio, and in the State governments as well. We, in terms of the environment, we don't have the same champions within the environment departments that the fishing industry and the oil and gas industry have in their departments. The industry department will go out and really sell the idea of oil and gas development.

The fishing department will go out and really sell the idea of fisheries. But the environment departments don't go out and sell protection. And that's, and so the environment departments tend to get caught up in wanting to try and do deals and come to compromises between the, with the others, with the other departments. We saw that in the South East Marine Protected Areas situation. So, when trying to bridge that science-policy gap, again, those departments, the development departments will have much stronger influence over where the money goes in terms of science. It'll have a very strong economic basis to it, to the science. Now, the resource departments don't have a problem getting their resources, but the environment departments do. So when you're looking at all that mix, that sort of science-policy gap is going to be accentuated from our point of view because all of any science will go into a fairly narrow area, rather than being much broader in terms of its public benefit.

What is the dominant culture in marine resource management and how does this affect the science-policy gap?
OP. Well I think I've probably answered that actually in talking about oil and fish, sorry oil and gas, and the fisheries departments and so on. Well unfortunately I suppose, in terms of the oceans, there's still this problem of out of sight, out of mind. There's also a problem that's it's still, oh it's big. And it can withstand a lot of stuff.

OP. Now unfortunately, they're pretty much stuck in this more exploitative mode, but they're now couching it in terms of sustainability. But sustainable resource management is different to ecologically sustainable resource use. And I think there's still a problem in trying to get industry and decision-makers to realise that there's more to ecological sustainability than they probably think at the moment. They think that if they can sustain a fishery, in terms of getting the same catch each year, then that's probably enough, whereas you need to think about whether in fact that catch being taken out each year, ok it may be able to replicate the catch, but is it actually sustainable in terms of the whole ecosystem there?

OP. There's some who realise what needs to be done, and there's others who perhaps don't necessarily want to realise what has to be done, and they're also very much influenced by the political circumstance of the time. But occasionally you'll get a bureaucrat who sees the need to really make some strong decisions, but I think we need more bureaucrats and others who are prepared to make those tough decisions, or recommend those tough decisions, and for governments to take those tough decisions on. I think we're still some- we're a long way from that yet.

4.5 Conclusion
In this chapter I have drawn out the key elements of the science-policy gap. These distil to a series of factors that coalesce into types and of those types the pre-eminent two are political and economic interests. In both the survey and interviews, political interests driven by, generally short term, interests are the main element in the gap. Short decision times are a critical element but this is a factor that results from the concatenation of politics and economic interests. In the following chapter I will focus on the economic and political as the wellspring of the gap.

5 Mapping the science-policy gap

5.1 Introduction

In tracing the science-policy gap through the primary literature the same themes recur; difficulties in understanding, dialogue and the 'two cultures' as well as the political use of science. The survey and interviews brought out a similar suite of concerns, prioritized by which respondent or interviewee saw the factors importance. But rising through all the various factors were two that are closely related and the most pervasive – political interference and economic interests. In this chapter I focus on these as the main causes of the science-policy gap.

5.2 The structure of the science-policy gap

I will characterize the science-policy gap using the analogy of a building. The occupants of this building (scientists, policymakers, interest groups) are naturally aware of the structure of the building as they use it day-to-day: Stuck windows, rattling doors, poor access, slippery floors, bad phones, jammed photocopiers, and the like. These structural factors that are encountered in the daily use of the building are like many of the factors of the science-policy gap described by the survey respondents (Table 4.1) and in the conferences held between 2000 and 2005 (Tables 2.1 – 2.4).

In this sense, many of the factors are experienced as part of the process of fisheries management and contribute to the gap, but as process factors they are readily and often identified (as seen in the tables mentioned above and many of the papers referred to in Chapters 1 and 2). The factors fall into these types:

- Dialogue; 'Creation of mechanisms to improve dialogue between scientific community and policy makers…'
- Understanding; encompassing cultural differences, education and knowledge about policy and science procedures.
- Integration; 'Closer links – especially in formulating research directions and priorities.'
- Independence; 'Essential that one retains independence both through institutional structures and by the scientific community.'
- Research lacking; 'So there's two, two holes in that direction; one is the existence or otherwise of relevant science, and the other one is the existence or otherwise in science that's in a form that's understandable by policymakers.'
- Policy failure; '… Where the decision-making process is poorly defined and not transparent and the exact role of science is poorly enunciated the gap will remain.'

These types of disconnect between science and policy that contribute to the gap can be, and are being, addressed. Although the frequency at which they are still mentioned and how they featured prominently in the survey response indicates that progress is slow.

The other feature of a building is its architecture. This is the shape, design, and functionality of the building and is influenced by the architects who have the final say in the built environment of the building. This is analogous to:

- Interference; 'The blatant political manipulation of science and policy to further economic and institutional factors.'
- Science leads policy; 'Make science the basis of policy decisions (rather than economic).'

These types of causal factors of the gap have the greatest influence on the gap, as seen in the survey (Figs 4.1, 4.2, and 4.10, 4.11) and in the comments made by the interviewees. As the chair of the Stockholm

'Bridging the Gap' conference observed, 'The biggest gap exists between commitments and implementation, not between research and commitments' (Axell, 2001). There is a great deal of research and many policy commitments to management that is sustainable and equitable. The rub is in actually implementing these policies as they were intended, when they are subject to interference that shapes and molds the outcome of policy intent (Rosenberg, 2007).

These are usually built into the architecture of policy. International agreements (such as the CCAMLR and the IWC) generally have 'objection clauses' whereby a nation not agreeing to a management decision reached by the organization (either by consensus in the CCAMLR or by vote in the IWC, for example) have a period of time in which they can object to that decision and then are not bound to the decision. In the CFP science and policy advice for management is subject to the decisions of the EU fisheries ministers during political negotiations.

The EU, in 2004, wanted to close some fishing areas in the North Sea to allow severely depleted cod populations to recover but was strongly opposed by the UK whose Scottish fishing fleets would be the most affected. The compromise was to reduce the fishing days allowed by two days and increase inspection to reduce overfishing. The UK still found this compromise unacceptable.

The EU also wanted to close part of an anchovy fishery in the Bay of Biscay and reduce overall quota by 85%, which was opposed by France and Spain. The final decision was not to close the fishing area and reduce the 2005 quota by just 10% (Smith, 2004).

The EU has proposed a 'radical' reform of the CFP; to bring in MSY catch limits, to ban some fishing and prohibit the dumping of lower value 'trash fish' at sea (Malakoff, 2011). However, the fishing industry opposes it because they say that it will cost thousands of jobs. Conservation groups oppose the reforms because they say it keeps inefficient and destructive fishing techniques going.

Ecosystem integrity and sustainability are not the leading issues in decision-making about fisheries policy, as Sturman (1972) noted:

> The administrator has a variety of measures to implement his policy objectives. In practice he is concerned not only with biological and economic factors but also with sociological and political considerations which may take precedence over the former.

Worldwide there are many policy commitments to ensuring that policy follows the 'best available science' to maintain 'sustainable fisheries', observes the precautionary principle and protect and preserve species and ecosystems. Doremus (2008) commented that:

> The second challenge arises primarily at the back end of the process, when the agency must translate information into action. This process requires that agency personnel measure the available information against applicable statutory and regulatory standards and decide what action, if any, to take. The concern here is one familiar to observers of the politics of the regulatory state – that the agency will undermine a statutory scheme by responding more to political pressures or the personal biases of agency personnel than to the evidence and the goals articulated by the legislature.

Doremus noted that in the US, in 2004, there were 1,596 'Schedule C' mid-level positions throughout the various agencies. Schedule C are political appointments that are 'policy-determining or … involve a close and confidential working relationship with the head of an agency or other key appointed officials.' It was one such person who altered the management of the endangered Pacific salmon in the Columbia River (Lichatowich and Williams, 2009).

Industry is also an active player. Bluefin tuna populations in the Western Atlantic have collapsed and the ICCAT has consistently ignored their scientific committee's advice on catch limits. In 1998, the scientific committee determined that a quota near zero was needed to restore the population of bluefin. U.S. tuna exporters hired a consultant to sit on the scientific committee. The consultant put forward a population model that omitted and reinterpreted spawner population data. This model was chosen by the ICCAT Commission and catch quotas were raised, the bluefin is now at risk of extinction (Safina and Klinger, 2008).

The political imperative can be seen at a national level. Norwegian whaling followed the advice of the IWC Scientific Committee when setting the Revised Management Procedure (RMP) tuning level of 0.72 to determine their catch limits. When the RMP method indicated the catch should be reduced, Norway lowered the tuning to 0.66 to allow the catch to be maintained and then to 0.62 (Fig. 5.1). In 2004, the Norwegian Parliament voted to adopt a tuning level of 0.60 and increase minke whale catch limits. Tuning the RMP to maintain or increase catches when the RMP indicated a reduction was needed is not sustainable (Papastavrou and Cooke, 2006).

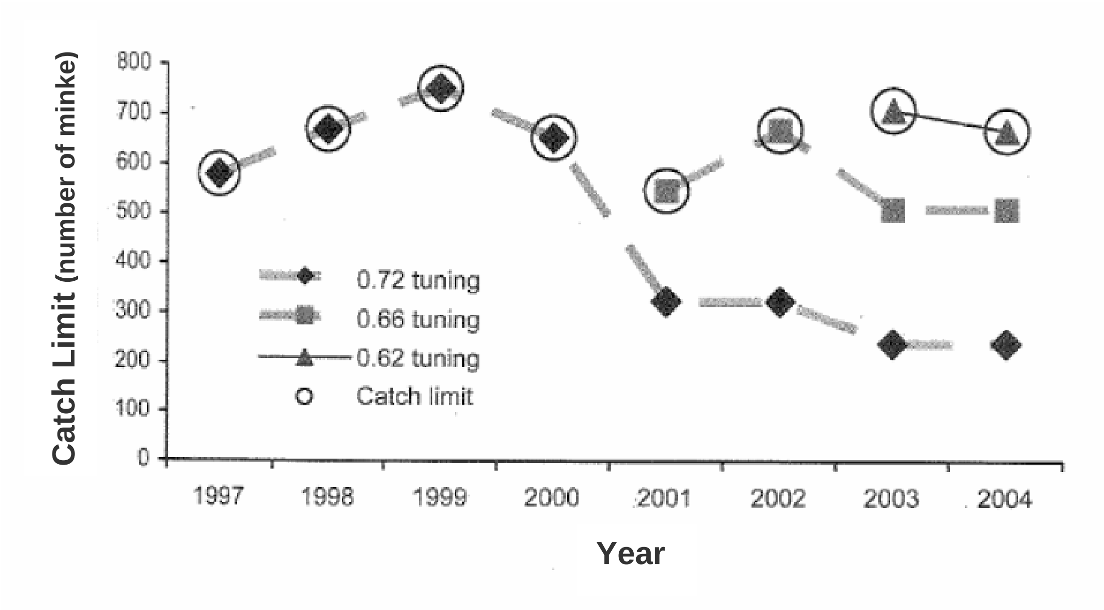

Fig. 5.1 Norwegian whaling catch limits. Whenever the tuning levels indicated that catch limits (circles) should be reduced, Norwegian authorities changed the tuning to maintain the catch levels. 0.72 was the tuning level advised by the IWC under the RMP, a management procedure which was adopted by Norway. (From; Papastavrou and Cooke, 2006).

This interference or difficulty going from 'commitment to implementation' was a problem keenly observed by the interviewees.

AB, the former Chief Scientist, noted:

> … I think the whole discussion about the economy, and the way those discussions are framed, that will always, and it has always, and I hope it doesn't always in the future, but at the moment the system that prevails mean that all of those arguments are privileged over anything lesser. That is to say anything to do with the community, anything to do with ah, you know, social good, anything to do with ah, education even, anything to do with the environment, sustainability, those are, those arguments about GDP, and about the economy and jobs, they will prevail at the moment. How do we do something about it?

CD, a senior policy adviser with a Commonwealth science and policy organization:

> A lot of policymakers are not prepared to make a decision which won't generate a recognised, a positive benefit until the next decade. That'll look like inaction and you know, lack of concern, even if in terms of the, say for the good of managing a fish stock, you know, you need to make a tough decision now, rather than a popular decision.
>
> … the attitude that well one more season, or couple more seasons at this level isn't going to change the overall outcome, so let's live with that. You know, let's leave it to my successor, dealing with the hard issues. … Well each level of the policymaker will have different constituents, *but at the top level, you know, the policymakers want to basically, on the whole, they want to look after the fishing industry and ah, and so on,* [my emphasis]and that's obviously got community benefits too, in terms of access to cheap resources, and so on. At other levels, the policymaker might be trying to appease other stakeholders who might be environment groups, ah, or whatever. But the problem is the focus on a narrow constituency and trying to find a decision which will appease the most vocal constituency, rather than looking at a, a more global group across the broader community.

IJ, the Australian marine project leader for an international conservation group:

> … I would define, the gap is where, whether it be a binding process or a non-binding process, that science advice going into the policy or management decision framework is being ignored. So there's a mismatch between, if science is saying, 'You need to reduce a TAC for a resource', and that doesn't come through in the decision-making process. I think the main cause is that there's a number of reasons. First would be that in many cases, it's a little bit like how national legislation considers stakeholder consultation; it's done on 'we will consider stakeholder advice', rather than 'it has to consider'.
>
> And it's this whole problem, which I think is now a global problem within fisheries, which is about whether you take a non-binding or binding approach to decision-making. And more and more, within regional agreements, and particularly as they relate to bycatch or related species measures, they are put into non-binding arrangements within a convention, say, that for example, in an RFMO, quite often resolutions or decisions of the parties to a convention are non-binding, depending on the convention
>
> So I think, back to the question about what's the cause of this gap, firstly it's this binding non-binding relationship; the other is that I think there's a lack of willingness, well there's a sense of moving towards a very well articulate, articulated management procedure framework, if you like, in some of these complex RFMOs, but in actual fact, which is meant to take away the political influence or decision-making, when you go from the science to policy bit, but no matter what, a lot of these conventions are either consensus agreements, or they're a majority by three quarters or whatever, and it's very difficult getting agreement, and that agreement is not a base about having a very clear procedure that's only based on the science, it's still about political will to do so.

The survey respondents clearly put political interference (1st) and economic interests (3rd) as the chief reasons for the science-policy gap. Their second choice, 'short decision times', is also a factor in interference as it relates to the election cycle and the behaviours of policymaking, which is about responding to emerging issues quickly and sharply with, as CD noted, not much thought or concern about long-term improvement or sustainability. The political/economic element has always been in the science-policy gap but in the last decade it has gained greater prominence (Rosenberg, 2003; Rayner, 2004; Daw and Gray, 2005; Lawton, 2007; Cardinale and Svedäng, 2008; Polachek, 2012).

This political and economic element is the main driver of the science-policy gap in marine capture fisheries. It is this deeper architectural level, one that shapes the management policies and actions that allows for overexploitation to continue as 'business as usual'. There are many other factors, identified in Question 19 by the respondents, and also by the interviewees that contribute to the uneasy relationship between science and policy but these are structural and are within the process.

The same factors are found in the primary literature and they can be identified and if the will exists and the funding is there they can be addressed. Rosenberg (2003) developed a conceptual graph that tracks the relationship between scientific research warnings, the state of the resource and management actions with political resistance (Fig. 5.2). As the resource declines, scientific warnings about the status of the resource increase. Management is slow to act and as it does, political resistance to the management changes increase.

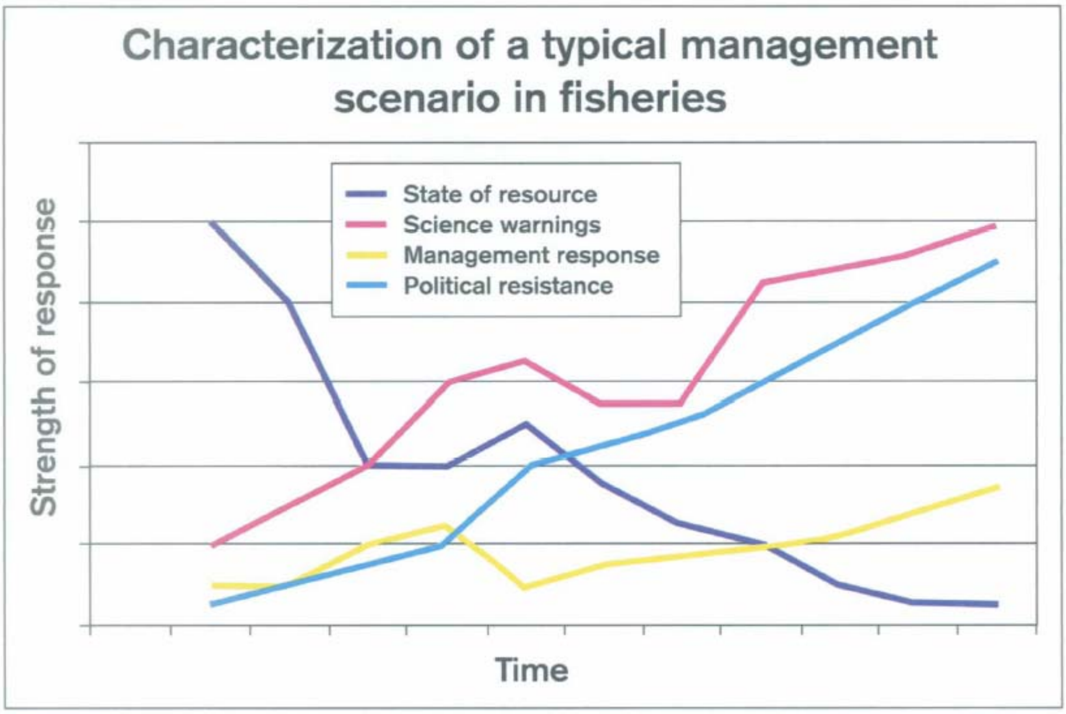

Fig. 5.2 The political and management responses to overfishing (From; Rosenberg, 2003).

Below, I develop a general map of the science-policy gap. This is based on Figures 4.1 – 4.3 and on the overall results for question D17 and A17:

If the scientific results do not support a political agenda:
Most likely to be ignored, dismissed or marginalised: **86.8%**
Least likely to be ignored, dismissed or marginalised: 13.2%

If the scientific results do not support economic interests:
Most likely to be ignored, dismissed or marginalised: **85.3%**
Least likely to be ignored, dismissed or marginalised: 14.7%

The 'science spectrum' is tied to the 'policy spectrum', in that as one moves along the policy spectrum from 'low political or economic interest' to 'high political or economic interest' the scientific results or advice is more likely to come into conflict with these interests and is so more likely to be disputed/ ignored/ dismissed or marginalised, even if the science is accepted within the scientific community (such as climate science).

This was simply stated by Nobel Laureate (Medicine) Prof. Peter Doherty (2005):

> In general, democratic governments from both the liberal and conservative ends of the political spectrum have no philosophical problem with supporting medical research. Like everyone else, politicians grow older and become increasingly aware of their own health and ultimate mortality. … The tension between science and government comes to the fore when the best advice that scientists can provide is seen by politicians as having acute, negative consequences on the economic (and thus the political) front.

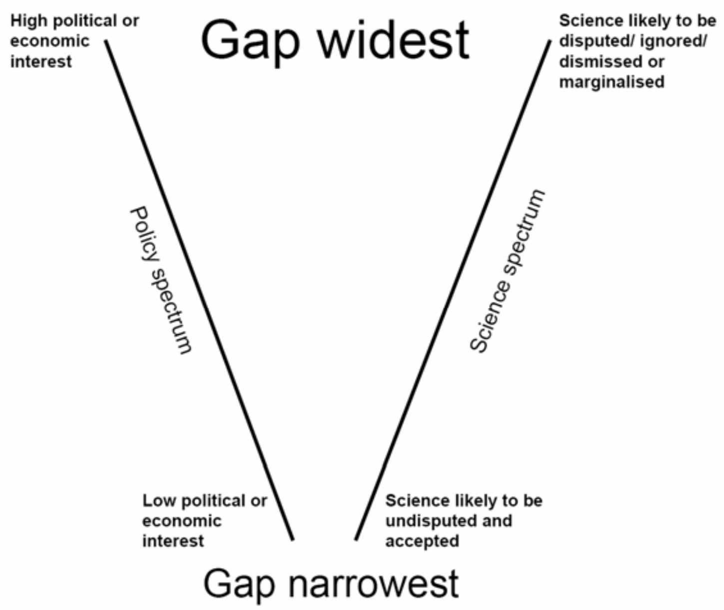

Fig. 5.3 Conceptual map of the science-policy gap. As political or economic interest increases, the gap widens and the science becomes more likely to be disputed/ignored/dismissed or marginalised.

5.3 Institutional failure

Since the main activity of fishing management is to maximise returns and the politics of fishing is continued exploitation (Rosenberg, 2003) and attempts to introduce other management measures based on science to reduce fisheries impact on marine life and ecosystems are resisted, it is pertinent to ask how successful governance and fisheries management is; especially in the face of science-policy gap. Since coastal states gained an EEZ under the Law of the Sea, the imperative has been to implement institutional structures that link science and policy for sustainable fisheries, using a variety of organisations and international agreements. Alcock (2004) has found that even twenty years after the implementation of EEZs scientific information is poorly transmitted into policies. This would be the structural elements of the science-policy gap; problems with dialogue, limited understanding, poor integration. Also the architectural elements as, particularly in the South, corruption and vested interests as well as lack of resources compound the science-policy gap.

International initiatives for sustainable fishing, biodiversity conservation and reducing overexploitation are widely accepted but there is a large difference between acceptance and implementation, with Mora et al., (2009) finding that only 7% of coastal states have rigorous scientific assessment for management policy; 1.4% have open and transparent processes for putting science into policy and only 0.95% have robust compliance mechanisms for fishery regulations.

With almost 60% of the ocean forming the high seas, RFMOs (e.g. CCAMLR) are now the management instrument of choice. Nearly all the global high seas are under the management of an RFMO. Callis-Suzuki and Pauly (2010) assessed the performance of these RFMOs against 26 criteria that reflect RFMO best practices. The organisations performed poorly and Callis-Suzuki and Pauly suggest that the primary purpose of RFMOs (or their member countries, e.g. the ICCAT Commissioners) has been to assist in the exploitation of fish populations with little commitment to conservation in the field. For fourteen RFMOs, the status of 48 fish stocks under their management was also assessed, of these, 32 (67%) were depleted or overfished.

The science-policy gap can be seen as a key part of the failure of these institutions. RFMOs, international initiatives and agreements to promote science-based sustainable fisheries and ecological integrity produce research on the status of fish populations, ecologically related species and the marine environment. When this research conflicts with the 'business as usual' mindset, the gap appears and the management regimes can fail in their intent. This is leading some workers to call not for more policies and tweaks to catch limits, fishing seasons, closed areas, etc., but for a straight reduction in current catches around the globe of between 40-60% (Roberts, 1997; Rosenberg, 2003; Roberts, 2007; Schrank, 2007).

Conclusion: At the Heart of the Gap

The differences between the purpose of science and the purpose of policy and the relationship between the two go back centuries. As science and technology became more ingrained and central to the activities of society this inter-relationship has grown but so have the stresses, blossoming in the post-WW II years. Anthropogenic effects on the environment have sharpened the discord between the 'use of nature' and the 'preservation of nature'. The stress is acute in short-term extractive use which leaves little behind and has collateral damage. The shifting baselines syndrome ensures that present generations know little of what the environment was like in the past, in both diversity and abundance. This is seen in sharp relief in marine capture fisheries and the depauperation of the ocean.

The science-policy gap is no figment but puts forward a challenge for sustainability, intergenerational equity and biodiversity preservation. The gap exists for multiple reasons. Some relate to 'The Two Cultures', problems of dialogue, understanding, integration, and independence. These problems are recurring and discussed repeatedly in the literature but they can be overcome, however, as structural elements in the gap they will not 'close the gap'. It is the deeper, architectural elements of the gap that must be addressed if there is to be any chance of reducing, or mitigating, the human impact on the marine environment.

The architectural causes of the science-policy gap and its appearance in the extractive use of marine living resources are political and economic in nature and result in the continuing overexploitation of the ocean for short term benefit with little regard for long term loss. Increasingly, scientific knowledge about the dynamics, interactions, interrelations between species and ecosystems, as well as the documented and continuing depletion of marine life put efforts to rein in this use in conflict with the economic imperative.

The functioning of the gap is most succinctly put in two quotes:

> … I will remind the authors of my insistence on a distinction between a conclusion and a decision. While this gap may be only inches wide, it is, in my opinion, a thousand feet deep.
> (Alderson, in Churchman et al., 1965)

> The biggest gap exists between commitments and implementation, not between research and commitments.
> (Chairman – the Stockholm 'Bridging the Gap' conference, 2001)

There are many commitments for sustainability and conservation, with the science to support them, but implementing them is the problem. In Chapter One, I preferred this quote from Snow (1959):

> But I believe the pole of total incomprehension of science radiates its influence on all the rest. That total incomprehension gives, much more pervasively than we realise, living in it, an unscientific flavour to the whole 'traditional' culture, and that unscientific flavour is often, much more than we admit, on the point of turning anti-scientific. The feelings of one pole become the anti-feelings of the other. If the scientists have the future in their bones, then the traditional culture responds by wishing the future did not exist. It is the traditional culture, to an extent remarkably little diminished by the emergence of the scientific one, which manages the western world.

It is the 'traditional culture' with a use ethic towards the environment that drives the science-policy gap. Unless, and until, the science behind marine capture fisheries is prioritized, or privileged, over short term political and economic interests, the gap will continue to exist.

This is the heart of the gap: The age-old attitude that the natural world is there for use is coming into conflict with knowledge, derived from science, that such use must be reduced or halted.
Until that conflict is resolved the gap will remain.

The implications and application of this thesis and further directions for research

The implications of this thesis are clear; that most of the works done to try and mitigate overfishing are failing for the single reason that they do not address the main source of the gap. As I mentioned earlier, there are numerous and varied instruments that try to address structural factors, all of which are worthy, but they fail because they do not address the fundamental elements of political interference and economic interests.

For example, Lawton (2007) discussed the 'information deficit' model, in which it is thought that if policymakers are educated and informed about the science and what it means, then policymakers will make the correct decision in the spirit of the many agreements and conventions that speak to sustainability and conservation of marine systems. As Lawton and others (e.g. Sturman, 1971) have pointed out, the science is not the most important item; political and economic interests nearly always carry greater weight[4] and no amount of 'clearly communicating evidence-based information to the public and to policy makers' (Likens, 2010) will alter that situation.

Attempts to alter management regimes also founder upon the reef of politics and economics because fundamentally they all address the structure, not the architecture (or even the foundations) of the gap. For example, attempts to integrate science and policy (another structural element) by using simulations and management strategy evaluations (Butterworth et al., 2010), address only the structure and will fail when facing the architectural elements. Da Rocha et al., (2012) showed that if 'drastic' measures had been taken in the CFP, fisheries would be far more productive today; while Sumaila and Huang, (2012) showed that if the bluefin tuna TAC had not been raised in 1983, the tuna population would 3.4 times greater today. However, again the architectural elements are the main issue, as interviewee *OP* points out:

> Now unfortunately, they're pretty much stuck in this more exploitative mode, but they're now couching it in terms of sustainability. But sustainable resource management is different to ecologically sustainable resource use. There's some who realise what needs to be done, and there's others who perhaps don't necessarily want to realise what has to be done, and they're also very much influenced by the political circumstance of the time. But occasionally you'll get a bureaucrat who sees the need to really make some strong decisions, but I think we need more bureaucrats and others who are prepared to make those tough decisions, or recommend those tough decisions, and for governments to take those tough decisions on. I think we're still some- we're a long way from that yet.

The application of the results of this thesis clearly lies in the direction of actually addressing the political and economic influences that lie at the heart of the gap. Da Rocha et al. (2012), and Sumaila and Huang (2012) point out failures in the delivery of policy under the influence of these architectural elements as has Daw and Gray (2004). Even international measures can be compromised as Callis-Suzuki and Pauly (2010) have shown. Lawton (2007) and others (from Ray, 1970, to present) have pointed out the need for science to advocate for ecosystems[5], to engage in the process and drive science-led policy decisions.

This is a difficult course to steer, despite the growing number of calls for science to engage in the policy process, rather than being simply 'honest brokers'. But it is an approach that needs definite and considered action in the near term as change can be slow and difficult, something that has been known for over 500 years: 'It must be considered that there is nothing more difficult to carry out, nor more doubtful of success, nor more dangerous to handle, than to initiate a new order of things' (Machiavelli, c. 1505).

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[4] For example, there is a substantial amount of research showing clear scientific evidence that 'no-take' marine protected areas (MPAs) are very effective as restoration ecology tools. Canada has 161 MPAs and of those, 160 allow commercial fishing (Robb et al., 2011).

[5] See also: Alm and Simon, 2001; Knight et al., 2008; Fritz, 2010; Meyer, et al. 2010; Schenkel, 2010; Bowman, 2011; Hughes, 2011; Reichert, 2011; Safina and Hardt, 2011

The need for science to engage with the policymaking process as more than 'data banks' can be found as far back as 1965, and this leads neatly to the possibilities for further research.

The 'honest broker' has largely been the preferred model for the engagement of science with policymaking for over a decade and it is a good model, but equally, since Churchman et al. (1965) there have been proposals for more direct involvement, growing more frequent in recent years. It would be worthwhile to study this dynamic and examine these calls for advocacy and engagement (see footnote 5, above) and develop this model, especially in this present time of unprecedented populist attack on the validity of science (e.g. climate change).

On a broader scale, research into the tension between 'science-led' and traditional policymaking, with 'science on tap, but not on top', would be fruitful. At an even deeper level, the foundations of the science-policy gap lie in the human-nature duality and teasing out that level and its relationship with policy results would be interesting.

A far more critical and important avenue of work lies in 'short decision times'. This was the second most frequent cause of the gap listed by the survey respondents. As a structural element in the gap, I have not focussed on it greatly as I was more interested in the deeper, root causes. In terms of practicality, research into this cause of the gap is an imperative. The precautionary principle is widely accepted but observed more in the breach. Da Rocha et al. (2012) found that fishery closures in the EU would be beneficial but 'drastic' given the socio-economic impact on the fishing industry. Putting the two together, it is the political need for decisions that do not affect industry in the short term versus the need for more long term sustainability is the driver for much of the short decision timeframes. Research into methods for longer time horizon policy, perhaps with a staged drawdown of resource use for sustainability would be rewarding. There is no direct reason why scientific research needs to actually be driven by the short term policy needs of the present, so seeking a way to disconnect the 'now' of policy and creating a 'future' research platform to influence and direct policy in the long term is critical; especially one that will not be subverted or compromised by the needs of the 'now' when it arrives in the future.

An emerging issue in all fisheries as the need for changes to fishing practice increases will be work addressing corruption in fisheries. As several researchers have noted (e.g. Hardin, 1968; Callis-Suzuki and Pauly, 2010; Doremus, 2010; Peterson and Stead, 2011; Robb et al. 2012; Sumaila and Huang, 2012) the success of fisheries policy lies in the observance of the rules and effective enforcement. If fisheries management authorities are seen to be corrupt, then lack of observance and rule-breaking increases (Sundström, 2012). Institutional corruption, where the function of governance turns towards favouring industry interests over policy or legislation, will be a fruitful field for research and development of countering policy instruments.

As the senior policy adviser *CD* said: '*…at the top level, you know, the policymakers want to basically, on the whole, they want to look after the fishing industry and ah, and so on…*'

FINI

* * * *

APPENDIX 1

The complete interviews

AB

At the time of interview, AB had recently ended his tenure as Chief Scientist for an Australian State. In this role he gave formal advice to the Premier and the Department of Premier and Cabinet (DPAC).

JS: So well firstly, in your own words, if you could just define the science-policy gap?

AB: The thing that I talked about in your presentation was the, the issue that you didn't state, and that was, as I described, the role of the bureaucracy, the role of the weak bureaucrats in the system.

I described them as jelly-backed, or in other terms, people with a wishbone and no backbone, basically, actually slow up the system. They're very reluctant to carry good policies through their agency, and the initiatives of their lower people in the agency might develop; they're very reluctant to actually take that up through the system, because: a) it's hard work; b) they often get knocked back, and it can actually create a tension, I would call it a creative tension, but they don't think of it in those words, a tension with their peers. And maybe other ministers. So there's often a problem where those bureaucrats don't do it. And I see an emerging trend in Australia, in the environment more generally, where there's no advocacy for the environment, and it's really the role of enviro- um, bureaucrats to do that in some ways, or certainly ministers.

But you talked... I'm digressing a little bit here. You talked a little bit about the Great Barrier Reef Marine Park Authority. That's a classic example, because that organisation was independent, independent statutory authority that had the capacity to advocate for the environment, as it did developing the Great Barrier Reef Marine Park Plan with the 30% protected areas and, and the response of the Government was to nobble that agency. There is no independent Great Barrier Reef Marine Park Authority now. It doesn't exist; it has to speak through the secretary of the Department of Environment. And, and that's an issue, because now we don't have anywhere, any advocacy organisations.

Now I was a commissioner on the Australian Heritage Commission when that existed, and that, that organisation had a very broad aim to protect the environment, the cultural and heritage and the physical environment of Australia. And, ah and it did that. It actually went out, in a very assertive, not aggressive, but assertive way and argued that things had to be more or less protected and valued. And in the end, what the Howard government did was to abolish the Australian Heritage Commission Act and put in a Heritage Council that speaks through the minister, through the, the secretary, then to the minister. So that again, was another step to weaken the capacity of organisations to advocate for the environment. And that's the subsidiary issue, in my case. First of all, you have the agencies run by bureaucrats who don't stand up for what needs to be done, the Jelly-backs, and then the institutional framework is changed so that it's even less likelihood. Those that can are no longer able to.

JS: Right, so when you're talking about Jelly-backs or that level, 'cause one thing that particularly intrigues me, is you have, I got a lot of feedback from scientists, ah from senior to junior positions or experience and policy workers who are working with scientists developing policy, just trying to accord with some of the, the acts and the intentions of the acts that they have, or that they're operating under, but there is also that gap which I was talking about between that sort of meshing, and that sort of understanding, and then the final decisions that come down from on high. So the Jelly-backs, they're not middle managers, they're senior advisers, or permanent public service, or Department Head, what sort of, what sort of tier or level of the operational system of government do they have, and how do they, and how much do they drive the decisions that the ministers make? Or the policymakers?

AB: The level that I'm talking about really is at the director-general/deputy director-general or secretary assistant, first assistant secretary kind of level. Very senior in the agencies. And it's those people who basically have to interact with the minister, to advise the minister, ah and they basically manage that business of putting submissions to cabinet, to treasury and so on about how they should be doing their business. So it's at that level, I think, where there's a failure in, in the public service as we know it, the institutional arrangements, in Australia at the moment.

JS: What sort of experience do you have of that yourself?

AB: Well first of all, I've worked in minister's offices for a period of about ten years, so I've seen what comes into the office, the way the advice is given; I've sat in those discussions between ministers and their senior staff, and I've worked in the department of premier and cabinet here, for three years.

So I've seen what's going through the cabinet office, and interacted with minsters directly and sat in meetings with ministers and their senior policy staff, and also I've done work on for example, whether it should be fisheries or another agency that manages the marine environment. So I did that, I ran a whole policy formulation program in that area. So I've watched those things happening, and I've also sat on those high level organisations, chaired committees, inter-agency working groups across this government and ah, been a commissioner on the Australian Heritage Commission.

At all of those levels, I see this pervasive problem of senior bureaucrats, permanent secretaries and things, trying to subdue the type of advocacy that comes from the, from within the agency, and the propositions, and the policy advice, trying to dumb it down, trying to make it easy, trying to make their own jobs easier and so on.

JS: Is this dumbing... there's obviously several, I'd say there's several strands for that because the way you described it could indicate that they have a second agenda in their decision. You know, they, they're balancing the advice, the proper advice, the proper information coming through their department as it's required, to, with other interest groups or other lobby agendas. That's possibly one reason, or is there another; is it just inertia in their own training or their own outlook that just makes them not, not respond to these, this information, or, what, what drives their lack of decision, in a way?

AB: Ok, I think I refer back to the wonderful, book called *Voltaire's Bastards*, ok?

JS: (*Laughter*) Ok.

AB: By, ah, John Paul... anyway. And basically he described this process, where, where senior bureaucrats filter the information that goes up to the top, so that at no point, is the, the government actually properly informed of the nature of the issue. Either the bureaucrats confound their ministers, by giving them so much information that they couldn't possibly deal with it within the short space of time that they have, and therefore they say, 'Oh it's all too hard, you tell me what I should do', or else they give selective information.

And I've seen all of that happening, I've seen that, that whole game that's described in *Voltaire's Bastards* being played out in all levels of government in Australia, there. But, but the problem of the Jelly-backs is much more acute than that, I think.

And the agenda, to go to your particular question that the agenda that is being run is a personal agenda, generally speaking. So most of those bureaucrats who get to that very high level, their first consideration is their own job, their own self-preservation. Their own comfort, actually. And so they always think about the, the issue, maybe not consciously but certainly there in the way that they respond, they think about it in terms of, 'Is this going to be difficult? How is it going to set me up for my next kind of, job am I continuing in this thing?'

Because I know I'm on a five year contract and, really the way I get my contract, extend it, is by appearing to be a good guy, a nice guy, and all of that sort of stuff. And so they're thinking to themselves, 'What's this going to do for my future prospects? How is it going to influence the way not just the ministers perceive me and not just the way the public perceives me in this job but my peers?'

Because when I get interviewed, at my next job, it's going to be my peers who sit there on that interview panel and give advice, and they're going to be judging me in the context of my interaction with them over the last five years. And this is the thing that basically, they're, they're not thinking about, primarily about the job that they're supposed to be doing, they're thinking about the job that they want to do, the job that they would like to be doing in the future, their relationship, their good positive relationship with government ministers and their peers rather than getting the precise job done. And we don't have a system in Australia that requires people to do their job. Ok? We don't have an accountability system which says, 'Ok, you were made the CEO of the environment agency, what have you actually achieved?'

The State of The Environment report tells us the environments got worse. How can you justify that with all of the money that we've spent, $200 million a year, and the environments now worse than it used to be? That never happens! Actually, occasionally you'll get an audit from the office of the Auditor-General or whatever you have at a particular jurisdiction who will look at what's called Key Performance Indicators, and mostly the key performance indicators they're set up by the CEO of the agency and mean nothing.

Here's an example: In most conservation organisations, where they have a, a sort of government policy commitment to achieve a comprehensive, adequate and representative reserve system, that's a, one of their mission statements, then the simple KPI is, 'What proportion of the state is in the reserve system?' So it goes from 13.2 to 13.3% in a year, and you've actually achieved something.

The fact that there's no actual measure of comprehensiveness, adequacy, representativeness in there, or that, you know, actually the land that was acquired to make that, you know, tenth of a percent difference, was flogged out bloody pastoral country that has nothing, no value, no biodiversity values, and then, having got there, how is this conservation estate being managed? Is the biodiversity actually being conserved?

That's why we're setting aside all of this land, specifically not because we just want land, but because we want it to conserve biodiversity. There is no measure of the effectiveness of the conservation estate. And so that whole system fails. You know, I think the, the director general, or the secretary of the department where they have a conservation estate should be beholden to ensure that the biodiversity values on the land that they have is conserved in perpetuity, which is what it's all about.

JS: And this is also despite, like at the recent conference, the scientists are all reporting back how much work they've been doing on developing biodiversity measures and adequate reserve systems and, and how to actually measure, you know, different land mass areas and model, you know, try to actually do their job, but it's not actually happening at the higher level, it's not actually being enforced.

AB: Yeah. I think, I think what's actually happening in the conservation estate debate is that although we talk, we have the language of comprehensive, adequacy and representativeness; no one actually knows what that is, and the bureaucrats in particular, the senior bureaucrats want something simple. And even the Auditor General, he doesn't want to know, 'Well this one is quite representative.' This one, this particular reserve isn't really adequate in the sense of some notion of adequacy. It's not 500,000 ha in the arid zone, and therefore it'd not quite, it doesn't do it. They're not gonna do that. The Auditor General will just say, 'Give us something simple'.

JS: And going back to an earlier comment, I mean apart from the simplicity, you're suggesting that on a five year contract, the senior departmental head or secretary is thinking about their permanency and their, or their future in, in similar roles and they're trying to impress their peers. That implies that there's possibly a cultural norm at that level, that may... I'm just sort of free floating here, but you know, you make up a story, if you go to a staff, you get a new job and you go to the staff dinner or something, and they sort of sit down and you say, 'I'm a vegetarian' or something, for example. And they all go, look at you oddly, and you're suddenly not quite one of them.

AB: You're branded as a poofter!

JS: Yes, yes exactly, yeah.

AB: Oh yeah, yeah.

JS: Is there a sort of cultural dominancy of, ah, I dunno, in ---- maybe the mining, beef steak sort of state, where, so if you start sort saying, 'Let's close down a fishery or put a marine park in here', and ignore the complaints of the primary industry vehicle, 'cause it's important for the future of generations, and come out with a sort of fairly sort of green line, would that be sort of crossing cultural boundaries that exist in that? I mean, obviously there are cultural boundaries, but at what, how receptive, in a way, or what sort of cultural community is that high level involved in, and how receptive are they to the need for real change for sustainability and future history?

AB: Ah. Ok. I suppose a number of dimensions here. Firstly there is a club. There is no doubt that there is a notion of a club, whether it actually exists as such or not. Certainly in Canberra, the so-called Mandarins get together from time to time, and they know all about their Mandarins and their, the so-called what we might call McCumquats as well, the people who aren't quite Mandarins yet. Ok? So there's that, a very clear understanding in that system, and they buy. They buy, they compete with each other, they, they make sure that they all know who's doing what, and so on. And that's part of the game that they all play.

It's not, I don't think, so obvious in say, in ----, but I do know that all of those CEOs of departments get together on a fairly regular basis, and they kind of eye each other of, like a pack of dogs, really. And they piss on the posts, and so on. They do that stuff, and it really happens. So there is a kind of culture where it's, it's generally you've got a much better chance of getting on if you're one of the boys. And I say 'boys' quite deliberately, because by far the majority of these people pissing on posts are boys, and they keep it that way.

JS: Yeah.

AB: So you've got a much better chance if you're one of the boys. And so there is that, that peer pressure. The um... there was something else I was going to say, haha I've lost my thread a little bit. Let me just think for a minute, um. Not there.

JS: I was just saying, if there is a cultural, if there's a cultural standard they adhere to, but also if they come from a particular cultural... ah 'cause like it has been said that I think in another comment by someone else, and in papers, I've read as well that they've said that, I think it was also in the Lawson paper which I must email you, unless you've got it yourself, said that the high level advisers are lawyers and economists, and the high level issues are ones that need to be addressed by the environmentalists, and scientists, and so, there's, there's completely different educational, social background as well. Is that, ah one aspect?

AB: There certainly is a sort of notional, professional hierarchy. So if you've got economics or legal qualifications, as the CEO, you are thought of more seriously than if you, and engineers are up there, engineers because, you know, it's a digression but basically engineers are taught to solve problems, and most of those problems happen to be linear, but that's a side issue. But they have that, and they think of themselves as problem-solving professionals, rather than just engineers.

So they're all up there in the first echelon, and someone with technical skills in, you know, the environment, or um, let's not put too fine a point on it, but someone who might have been a curator of paintings, for example, and that was their professional domain, they're not given a look-in because they don't understand the real issues.

JS: Yeah.

AB: So there is, it's very hierarchical and if you get there as a, a curator, it would be a very unusual thing. It's happened, but it's very hard to sustain being there. If you look at the discussions and debates about art curators and managers of museums and art galleries and all of that around Australia, you'd see it's a, they get flicked over you know, at almost two year intervals.

JS: Yeah.

AB: They change, just because they're not regarded within the public service hierarchy as people who have their feet on the ground. So that's an extreme example, and sad to say, it happens. And it's completely unfair. But the other thing, that, that follows on from that is that basically we have a situation in Australia, and this is not the only country where it happens, where people with business qualifications, MBAs, people with economics degrees, all of those sorts of things, are more highly regarded in government because of the economic rationalism that prevails as the thinking framework in government, ok? So basically you've got a situation that's emerged in Australia in the last twenty years where the strictly economic rationalist theory has come to be the dominant paradigm of government, throughout all of the jurisdictions in Australia.

And, and it works, it manifests at all sorts of levels, but as an example, in this government here, for example, if a cabinet minute, just supposedly if a cabinet minute comes into a cabinet office, that's about implementing a government policy for sustainability, you know. And everyone has said we want to be a sustainable government and you know, those commitments have been made, this policy is cabinet minutes comes in. And it says, 'Ok, this is what we want to achieve, and it's got long-term benefits to the community, to the economy, to the environment, blah blah blah, and it's gonna cost, you know, for argument's sake, $20 million over ten years'.

The fact that it says 'this is going to cost something' means that it goes into the cabinet room, it's immediately referred off without any real discussion to the expenditure review committee. The expenditure review committee is shared by the treasurer, and has a couple of other ministers, and all the rest of the other people around the table are treasury officials. And they will say, 'Um, we've assessed this, and we note that it's going to cost $20 million over ten years. We don't think that the budget can stand this extra pressure'. And that's it! Regardless of the fact that it's a policy position that comes in, those treasury officials use their power to basically govern all decisions of government, to control all decisions of government.

And that's not an unusual thing, that's using the example that I see from my observations, working in premier and cabinet here. that, that is common in all State and Commonwealth jurisdictions, that the financial advice somehow overrides any real policy considerations, regardless of whether they're for the good of the community or not.

So that issue then of the, the, you know, we can go on to a discussion about the economy and how it's constructed and all of that sort of stuff. Basically my view is, it's a pack of cards, its complete hocus pocus, a theory that can't be substantiated in any, in any way, but it has been adopted, and it's got its own momentum. And the weight, the force of that, is that it basically rules the nation, at all levels of government. And in business.

JS: And, sort of following on from that, where in that hierarchy, in relation to the economists, lawyers and the curators, would science fit?

AB: Well, I think, science is, is, would be above the curators.

JS: [*Laughter*].

AB: But certainly behind the engineers, and not thinking of a particular hierarchy, but if you had to, if you had to think about it, and you can actually see this in the way that cabinet positions are allocated in governments, the environment is at the bottom of the hierarchy. Ok, so basically, except maybe now, in the new federal government, where you've got Garrett and, and Penny Wong basically running that whole environmental discussion or debate. That would be the exception. For all of the Whitlam years you had ---- ---- who was a complete nobody. Nice guy, small business man, complete nobody who never did anything.

And you know, I would go into his office and say, 'This is what you need to do, Minister.' 'Oh yeah, thanks very much, hahaha', because he knew that he'd be laughed out and that was a reformist government, you know. So, you can see that situation, where basically you've got all of these so-called economic drivers, the so-called economic drivers like agriculture, forestry, fisheries, mining, all of those things, they're well ahead in the, in the hierarchy of science, however we might think about it, but certainly where you, if you look at the Minister for Science, just in the pure science, where is the Minister of Science, if that person ever existed?

Barry Jones might be a good example. Barry Jones, Minister for Science. He was a wonderful person, full of ideas, but he was regarded as a laughing stock within cabinet. And he never did anything. You know, while he was Minister for Science, CSIRO slid out the back door. He just, he was given a job where they thought 'this is a good way of keeping him out of mischief' [*AB laughs*], but he did a few good things. One of the good things was putting together the, the Commission for the Future, which was basically a science based, taking science into the community and all of those sorts of things. That was then abolished, by Howard [*AB laughs*].

JS: If the environment, or decisions about sustainability and the environment as we know it, are not privileged or not regarded, ah, what is more important and why?

AB: What is more important? Well, I think you and I would agree that those discussions about the environment need to be heard. Those, those concerns about the environment, they need to be on the agenda, and they need to be articulated. I think; I come back to that point that we need advocacy for the environment. We need advocacy for sustainability and for too long, that hasn't existed. So somehow we've got to find a way to bring the issues that come out of scientific endeavour. Well, let me just say, I think we've gotta have a better level of support in Government for science, for research of all kinds. And in Australia as it is at the very lowest ebb of its investment in knowledge. And I talk about knowledge rather than science, because you get a scientific finding, and that can be translated into an application that we can do something with. And I think about improving our knowledge, our level of understanding of how the world works and how human beings ..., and how humans themselves work 'cause science includes the study of life on earth and the human body.

I think we've gotta have that better level of investment, and a part of that has also to be an understanding that the knowledge that's generated belongs to the community. And so there has to be a, an acceptance of the capacity of scientists and those knowledge brokers to actually spell out their knowledge. Ok? The universities have failed in the last twenty years, ten years in particular for obvious reasons, but the universities have failed to be knowledge brokers in my opinion, they've become much more businesses, competing against each other and also, making sure that they were sustainable economically, that economic driver has actually lessened the capacity of the university to articulate and take the knowledge to community broadly, as well as students.

JS: Ah yeah, and now they're - universities are censoring or limiting their own staff's comments as well, which is part of a corporate push, I understand, so... But, just to wrap up, I mean, if, that's one way forward, you were talking about that there must be advocacy, or a clearer spelling-out of issues and consequences from science to policy decision-makers, and it still comes back to a privileging issue, where you know, where you say this is the situation, this is the consequences, and other, other issues have a greater privilege over those scientific ones.

How because you can take the horse to water but you can't make them drink, so you could provide all the knowledge and then take all you want, to actually, to make privilege of, you know, a particular scientific issue or a particular scientific problem, or an environmental problem perhaps, trump, or become more privileged than other issues, is going to be the big question, how do you see that? Or firstly, what are the other privileges that triumph over environmental or sustainability concerns, and how would those, apart from knowledge-broking, how would those environmental and sustainability concerns trump these privileges at the moment? So what are the privileges, and how can they get deprivileged?

AB: Well, I think, I think the whole discussion about the economy, and the way those discussions are framed, that will always, and it has always, and I hope it doesn't always in the future, but at the moment the system that prevails mean that all of those arguments are privileged over anything lesser. That is to say anything to do with the community, anything to do with ah, you know, social good, anything to do with ah, education even, anything to do with the environment, sustainability, those are, those arguments about GDP, and about the economy and jobs, they will prevail at the moment. How do we do something about it?

I think one of these real challenges is for us to change the nature of the economic discussion, of the nature of the understanding of what, what good metrics of the economy might be, that include all of the other quality of life measures, for example, and the environmental measures. So we move from a daily broadcast, or you know, a many times a day broadcast of how the economy is doing, as measured by the share market or the interest rates or so on, to an equivalent reporting and in people's consciousness of the way the society's doing, or the wellness index or something like that. And as I've said, the current metrics that are used for the economy are a complete pack of cards; GDP is a nonsense.

So we've gotta break that nexus, I think, where that is the thing that people use as the yardstick, it's in our face, in our mind, it's in our ears every day. The second thing is, that I think we're at the point now, and maybe with the present national leadership, we might get, might take advantage of this opportunity, where other things are on the agenda. That is to say, you know, there's a lot of discussion about climate change and how that's going to affect us. And climate change is a, is essentially a, well I describe it as a market failure, but actually ---- says, 'No it's not a failure, that's exactly the way the market works'. And that's exactly what I'm saying, it is the pack of cards that drives... all of the drivers in there are completely wrong. They will, they will destroy us if we leave it the way it is. So, I've lost my train of thought. So, we need to change the metrics, we need, we need, the capacity to actually.... bring those discussions about the environment into the public domain more clearly.

Now, the climate change debate is the classical one. And just draw some parallels there. What's actually happened in the climate change debate is that individuals in the community have become concerned. And there's been an upswelling of interest in all of that. It's been facilitated by, you know, Inconvenient Truth movies and the work that the ACF has been doing to spread that message. But basically the community has become concerned. And that has been, that has empowered politicians to take it on. I think if we can use that as a model, then a lot of those other concerns might arise. Now, one of these problems that we have in Australia and many other Western so-called democracies is that we don't have a culture of discussion and debate. Ok?

So what, what people take as their truth is the two minute grab that they get from the commercial media, in particular. The vast majority of Australians tune into commercial television and radio. So what they get from there is their truth. And there's almost no discussion in any serious and meaningful way, amongst the vast, I won't say the unwashed, the vast majority of Australians don't actually discuss issues of politics, or the economy, or the society, amongst themselves. It just doesn't happen. And, and I think that's one of the great threats to our democracy actually, because unless you have that actual capacity in the community to think about the issues, to discuss the issues, to, you have the confidence to express your own view and carry that into the ballot box, you have the understanding of the range of views about a topic, all of that, we're going backwards. And the decision of the Howard government to actually free-up media ownership rules means that we've gone from, you know, 200 newspapers to two.

JS: Yeah.

AB: So we're only getting two views rather than all of those little rural presses and, they don't exist anymore, they've been taken over. And that is a trend which I think is something we've gotta overcome too, with my model for that is really the, Swedish model, in particular, where a certain amount of the national budget is allocated to running, the process of running discussions at the community level.

And those discussions can be, you know, you have a particular agenda and they can decide on their own agenda, and then the outcomes of those discussions can actually go up through a regional discussion process to become law.

JS: Yeah, well that will never happen!

AB: [*Laughter*]… There is an issue that you'll need to follow, I think through very carefully, and that is, the issue, the understanding of 'what is policy', ok? Because there are many things that trade under the name of policy.

For example, a policy commitment by a government at the time of an election. Which is really, in a sense a wish list, really a wish list or a commitment in general, in general terms, and there are, you know, political parties have policies more generally, sometimes, say the ALP national conference, they adopted what's called a platform, which is actually in my view, policy. But it's never taken on as policy by the government when it wins power.

The policy, the whole idea of policy, in my understanding, is a, is, a simple understanding is policy formulation is something that you do when there is an issue about which there's some debate when you need to resolve some debate, you need to resolve the issue, or some new emerging issue, where you actually have a policy formulation process. And ah, I think a lot of the other things that trade under this name of policy are completely different. So where you've got a consensus, do you really need policy? Strictly speaking, it's where there is a need to do something, and the need to gain an agreement on a particular point of view. And ah, I think, so I think that issue of what is policy, and how is it, how is it understood, it's a very diffused concept, the way the word and the concept is used in Australia, and I think that it might be something that you could usefully tidy up.

-END-

CD

At the time of interview, CD was a senior policy adviser for a major Australian Commonwealth science research and policy organisation with an ocean science focus.

JS: Ok, how do you define the science-policy gap?

CD: I haven't tried to put words in a, a definition sense, but ah, I know it when I see it, so I say there's evidence of ah, gap. But it's a cultural issue, which is precisely how I would describe it. It is essentially an issue of, policy people having particular needs and expectations of science and scientists having different perspectives and needs, and the two groups not actually explaining to each other what their needs and perspectives are. So it's essentially a cultural issue, to my mind.

JS: Ok, so for you, what is the main cause, which you've probably already answered, but if you can elaborate?

CD: Ok. Well ah, I think there are several causes and the attributing one has been the most significant, I think would be a little bit hard for me in this ah, start writing all my thoughts down, but I think some of the issues that relate to the culture are that policymakers need science to help them make their decisions, but they need, the information in a timely way. And only sufficient information for them to make a policy judgement. Scientists, on the other hand, expect precision and scientific certainty. And are prepared to work for years to get scientific certainty; they're not comfortable in putting caveats and qualifiers on the advice that they give, and I think that leads to part of the difficulty, because the scientists will say, well I haven't got the results fully worked out, and the policymakers will say, 'Well, give me a hunch', and the scientists will feel distinctly uncomfortable, ah about that. I think there's a, it's probably, do you want me to keep, elaborating, focusing on those sorts of issues?

JS: Yes, yeah sure.

CD: I think some of the issues too relate to the pathway by which the scientific information is made available, ah to policymakers, and I think that's an issue which really has to be examined to close the gap. And I say that because the scientists, ah typically, will want to have their work published in referee journals, and will make the assumption that once a paper is published, then it's accessible and understandable to the policymakers or whoever else needs to see it. Whereas the policymakers are not inclined to be scanning the scientific literature. They need another layer of interpretation, which will come from the people who are the analysts of the scientific research, and those analysts can in fact be scientists themselves, but they need that information instilled into the key message, the key implications and so on.

Scientists as a group are generally not good at translating their work into the language the layperson or the politician or the policy adviser can take and use immediately. 'Cause I think that's a significant issue. And I think we've seen plenty of examples of the pathways for the information breaking down. And we see examples of that, say in climate science, where there are several ways of publishing the scientific information in the literature and in conferences and so on.

But the policymakers are scattered across various institutions and organisations, in international bodies and so on. And they each need to have the information delivered to them in a way in which, their culture and timing needs and so on operates. And it's not a good match between the two sets of mechanisms. I think there's another cause of the policy gap, and that is what's the prime motivator for individuals to do their work? And this is a comment about, ah some of the scientists I see operating day to day, and that is that for the scientists, the advancement of their careers is driven by the number and quality and reputation of their scientific publications.

That becomes the driver for the nature of the research they do, whereas the policymaker wants to have the information from the scientists, irrespective of whether it's actually brilliant science that will get published and will advance the scientist's career. So there can be a fundamental tension there, where a policy adviser needs to get information which might, say, show trends over time of a certain parameter within the environment, or within climate. But the scientists will say, ah I'm not interested in just monitoring a particular parameter, because, that actually won't get me a referee publication, or it won't get me a PhD, or whatever it is. The policymaker feels constrained in her ability to direct the scientist to produce a particular piece of work. The scientist will say, also, you can't constrain the work that I do, because I need to follow the line of scientific enquiry and see where the line of thinking takes me, rather than answer your particular commission need. So you know, there's several layers of cause there.

JS: Ok and how do you see this operating in practice?

CD: Ok, well, maybe to give an example, say in climate science, I think...

JS: In marine science?

CD: And in marine science too, if you like. ok, in marine science maybe the issues are a little bit simpler because I'm familiar with say the CCAMLR environment, where the science has come to the point where, it has a clear understanding about where the science can actually make a difference to the policy judgement, and we have a scientific committee within CCAMLR which can help design the programs.

And as it were, tell scientists, these are the things where we need your advice and your scientific evidence. So that can work quite well. But in other areas of science they don't have a body there, which is, which all the science is absorbed, analysed and considered before going to the policymaking forum.

Ah, I was gonna mention before, the, in the climate world, where suddenly there's this huge amount of public awareness and concern and therefore political concern about it. A great hunger for information. And that's manifested itself in, a proliferation of advisory bodies, councils, intergovernmental bodies and so on. All after this information. But all of these players in the policy side of the market are not coordinating their needs in any political way, and they're going to different scientific groups asking for the information that they want. And the scientists I think are almost getting to the point where they're saturated with requests. And also confused about who is the prime user of the information that they want to generate. Ah, and that leaves the potential for there to be gaps, where things don't get done, or for things to be oversupplied, or there to be conflicting evidence and so on.

JS: Ah, ok. So in a real-world situation, probably covered that!

CD: Yeah.

JS: Ok, so what main social political tensions do you think are behind the gap or whatever? Sort of socio-political drivers?

CD: Well, there's an issue of objectivity of the science. I mean I think there's some real issues about policymaker's cherry-picking the science that suits the answer that they want to achieve. I think that's a real risk in many areas. I think there's a lot of cultural issues that we, we mentioned before, are in there as well because sometimes the, the scepticism that policymakers might have for how scientists work and whether or not they understand the issues, are prepared to produce information, in a, in a timely way, that's addressed the very specific issues. So that's a question of the control with which the policymakers feel that they have over the scientific community and its ability to deliver to their needs. Those sorts of issues.

JS: Ok. So, how do um, if you consider that's policymakers and scientists, how do the decision-makers fit into that mix?

CD: I think the decision-makers like to feel that they're ultimately the clients of the science, and therefore should have the greater say over what the science, what science should be done. Policymakers would like to feel that they can control access to the funds and sort of apply pressure to science, to make sure it delivers only on their needs, I think a lot of policymakers are very sceptical about the pure sciences which are simply, I shouldn't say simply, but are aiming at describing the world and looking at things which may one day be useful but aren't immediately useful, because the policymakers almost inevitably have a short-term horizon; they're looking at the next one, two, three years, and policy decisions of course are looking at electoral cycles.

Scientists may however, want to look at things which are of enduring importance, and you know, lines of enquiry say in astronomy for example, there are lots of scientists who want government to invest millions and millions of dollars in astronomy, whereas policymakers would say, well that's all very well and I'm sure they're interesting things but not useful things that you can find. They're not actually going to improve society and community. They're not going to provide an economic return to government.

JS: So, who are the decision-makers in this sort of area, do you consider? Not names, but.

CD: No. Oh predominantly the decision-makers you know, at the political level with ministers and so on, but ministers are very much influenced by the quality of the policy advisers which operate in government and various advisory bodies and so on. So the job of the scientists is to convince the policy advisers in the bureaucracy and the expert panels appointed by government and so on, 'cause if they can't convince them, they can't convince the ministers.

JS: Right.

CD: So that's really where the influence has got to be exercised and the condensing argument to be made.

JS: Right, so earlier on you talked about cherry-picking and objectivity, that sort of implies issues of trust of science. So is there much trust? Is that part of the mix?

CD: Oh, look, I think there's a long way to go to build trust in the relationship. I think, scientists resent the scrutiny that comes from the policymakers looking at their work and you know saying that's not the answer I needed, or it's not quick enough or whatever, ah I think they resent what they see as sort of naive interpretation of the value of their work, and so on. In some ways, I think from the policymakers perspective, they can be reasonably sceptical about whether or not scientists are telling them the full story and giving them all the information they need to make a balanced set of information to make informed judgements. And we've seen, you know, several examples where scientists have been selective in their use of data. Or the data's been presented in a way that it can be used selectively. And that doesn't help produce the trust that you need.

JS: Right, so what would you say is the dominant culture in marine resource management?

CD: In marine resources?

JS: Yeah.

CD: Yeah, um... In marine resources research?

JS: Or management.

CD: Or management. Yeah, ah that's a good question. I think the, there's still a sense that, and this would be reflecting a personal concern of mine; that people are prepared to take policy decisions on the base of insufficient, ah information, and be too optimistic about the level of resource that's, ah available. And use lack of certainty as an excuse for not having a, you know, a conservative approach to stock management, that's a real issue.

JS: But, what sort of culture would that reflect then?

CD: Well, that's a culture in the policymaker's perspective of trying to look after the industry and pressure groups' perspective, and that's potentially quite dangerous because you know, you get a short-term political fix and have long-term you know, failure. Because decisions are, you know, not sustainable.

JS: Yeah, but ah, in terms of the science, the feedback from science about the conditions of you know, living marine stocks, how would that influence that culture? If there's a continual sort of cycle of fisheries collapse? Is there a gap there as well, or?

CD: Oh well, yeah there's definitely a gap there. I guess from the perspective of the scientists, you know, they actually wanna see their advice taken seriously, and they wanna be properly resourced to be able to, to get the information that they require. Whether there's a sufficiently trusting relationship I, I mean I can't be sure, yeah. Well, I don't see it myself in the part of the world that I'm operating in, that they're significant problems.

But that's because my area of experience is, say in the CCAMLR area, in the recent, past decade or so, the quality of the science has been significantly better and more focused and so on, and there's been some quite intelligent and creative approaches to stock assessment and ecosystem you know, analysis and all that sort of stuff.

JS: Yeah, well that's part of the reputation that it has everywhere.

CD: You've got a particular interest in the marine side?

JS: Ah yeah, the marine side. Looking at the fisheries, fisheries management side. Yeah, so that was part of the, part of the question as well, so if you consider the backgrounds or the culture of the decision-makers, are they, do you think they have generally a background in understanding the issues about managing marine resources?

CD: No. No they don't. No, I'm sure they don't, and part of the problem is that policymakers on the whole tend not to be in that part of the world long enough to pick up all the issues and the nuances, the policymakers are often looking at a very short timeframe. In some situations they may, might only be looking for enough confidence to be able to get through the next meeting, you know. And we're not talking about the next year or decade of this issue; that's left to others or not addressed at all. So, I certainly agree that there's a problem created by the ongoing movement in the policy advising and policymaking force.

JS: So there's a, a turnover of staff, as it were, or the classic sort of idea of someone moving out of the career path, does that, what would their main drivers for their decisions then, their thinking, if they're not coming from a nuance background, even though policies can sort of have things like precautionary principle approach, what would be their main decision drivers?

CD: Well a lot of, I mean a lot of them just simply want to make a difference, and sometimes that might require making a decision almost on the basis of what's good for their reputation, rather than what might be good for ah a long-term, you know, what's good for a long-term policy outcome. And I think that's significant. And we certainly see that in the advocate level of policymaking, but you can get a lot of short-term fixes without a, you know, a long-term strategic view about the consequences, and the accumulative effects of certain kinds of decisions.

JS: And those short-term fixes, what's their general intent, what are they trying to fix in terms of?

CD: Oh, placate stakeholders you know, in the short-term, and maintain peace and harmony around the negotiating table, or to be able to come out with a press announcement that looks impressive on the day.

JS: Yeah.

CD: A lot of policymakers are not prepared to make a decision which won't generate a recognised, a positive benefit until the next decade. That'll look like inaction and you know, lack of concern, even if in terms of the, say for the good of managing a fish stock, you know, you need to make a tough decision now, rather than a popular decision.

JS: So they'll postpone, have a closure or...

CD: They may well do, they may well do, yeah, the attitude that well one more season, or couple more seasons at this level isn't going to change the overall outcome, so let's live with that. You know, let's leave it to my successor, dealing with the hard issues.

JS: Yeah, pertaining to that as well is the approach, or the attitude if you're talking about the decision-makers not having a scientific or understanding background of fisheries collapse and fisheries pressure, when they come into those situations, ah, who, what sort of, who are they trying to sort of placate, or what's their main driver? What do they want to see happen?

CD: Well each level of the policymaker will have different constituents, but at the top level, you know, the policymakers want to basically, on the whole, they want to look after the fishing industry and ah, and so on, and that's obviously got community benefits too, in terms of access to cheap resources, and so on. At other levels, the policymaker might be trying to appease other stakeholders who might be environment groups, ah, or whatever. But the problem is the focus on a narrow constituency and trying to find a decision which will appease the most vocal constituency, rather than looking at a, a more global group across the broader community.

JS: So just more generally, speaking from your experience, how often does the decisions depart from the policy?

CD: Regularly. Yeah. I mean, the policymaker will always deserve the right to make the decision, taking account of the, the various pressures and influences that they have. The role of the scientist really is to provide the information for them to make an informed decision. Once they make an informed decision then they'll be fully aware of the consequences of their decision. Ah, I think it'll be very difficult to get to a situation where policymakers will automatically accept the advice of the scientists and to implement it on its face value, without taking into account other perspectives, but not the science perspectives.

JS: Right, I was interested also, quite a few to the minute treaties, international treaties and policy documents have those outs, but they often, you know, in the mission statements they'll sort of say, 'We will abide by the precautionary principle' or, 'We will manage for the future', or 'We will use sustainable development'.

CD: Yeah.

JS: But then the decisions often are the reverse of what's actually plain. And so, you know, I was just wondering, is that a regular occurrence, or anyone tries it?

CD: Yeah.

JS: And the decisions there are made, based on...

CD: Well it might be you know, what you can get away with, or it might be based on the closest you can get to the best fit among all the different pressures that might be on the decision-maker. Yeah. I mean, there would be all sorts of drivers for decision-making, which some stakeholders might say is dodgy and others say is brilliant.

JS: [*Laughter*]. Yeah ok, going back to the science, as you said, there's this sometimes indeterminacy, or how the models will work, how do decision-makers take into account the banding of uncertainty, do they take the high end of the uncertainty, so there's an error of...

CD: Depends on the issue, but often they'll take the, that end of the uncertainty which gives them the best outcome for the stakeholder that they're trying to satisfy. So sometimes that'll be taking the minimum, sometimes it'll be taking the maximum, and sometimes it'll be outside the error bars as well. Yeah. I think probably the decision-makers would like to know, would like to reduce the span of the error bars, but they don't want to wait to get their scientific certainty so they've got a precise number. You know, 'cause that could take forever. So there's a balance here as to the quality of information you get from you know, the number of caveats you've got on it.

JS: Ok, we'll finish there.

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EF

At the time of interview, EF was the director of a major Regional Fisheries Management Organisation (RFMO).

JS: So you were talking about the definition of science-policy gap, starting with science.

EF: I think importantly, I mean I think one has to understand why an orange is called an orange is, you know... So to me science is a sort of systematic, a systematic accrual and a systematic formulation of knowledge. Really, or an address or. And I mean there are a lot of different things around, there's a question of investigation, there's a question of hypothesis testing, there's all, all get the issue. I think on the other hand, you know policy is rather, if you like, in some cases practically based, but it's normally the practice of statecraft, outlining the course of action.

Now that doesn't mean that that course of action cannot be systematic and formulated; it just means that it is differ-, there are different drivers, one believes that science is essentially being done, if you will, to advance the state of knowledge. Ah, policy is being done to carry out, or to achieve some target, some identified course of action, in other words. So I think that that's an important distinction because when you come to talk about the science-policy gap, what you're saying is that, that in my view is that science actually, is possibly more rational in its outcome base than policy might be. Policy is interpretive in its outcome base.

And there's a slight difference, and you can argue the semantics of interpretation and rationality but, and I think, what a lot of where that gap arises is plainly and simply the expectations are completely different. In science, the expectation is that even the wrong answer is useable, if it's been obtained in a systematic, rigorous formulated way, because it tells you something. Policy is not looking for wrong answers. Policy is looking for the best option. Whatever that might be. And it might be a completely, off the wall kind of thing, but it's the best option. So very often, when you look at this gap, there's a bit of incredulity on the scientists' part when the science says, 'Well it's obvious from the scientific point of view, this is the, this is where you end up if you follow this rationale, if you follow this reasoning'. From the policy point of view, the answer is, 'Well I don't wanna end up there, I wanna end up here, I want you to give me the information that gets me there'.

And the scientists would turn around and say, 'Well that means I have to then pick and choose amongst my own information, and as a scientist I can't do that'. And the policy person would say, you know, 'Well I have to do that'. And, that's where it starts. And that to me is the gap. That, that complete, if you like, oranges on one side, apples on the other, never the twain shall meet. That really is, is the problem. So, what happens in practice? How does this manifest itself? Well it manifests itself in many ways by essentially a blame game.

A scientist will say about a policy decision that it's generally not in the interests of the science. What do they say about that? Well actually, you can't expect that outcome; you couldn't expect that outcome because you hadn't taken cognisance of the best, of the science, what the science is telling you. So you know, well that's your fault.

And the policy, if you like, practitioner, will say, 'Well I've had all of these things, I have had these outcomes in mind, or these practicalities in mind, you haven't given me the equipment. I have to pick and choose between those, and you know, you set me up to fail. Irrespective of what the science may or may not say'. Or, 'You haven't given me enough insight into the science for me to have set up this practical outcome, on the basis of the fact that I don't understand what you're saying to me. So it's a misunderstanding here; it's not my fault. It's your fault for not telling me properly'. So this, then it becomes a blame game. It's plainly and simply a blame game. The politician says, 'Well that's what the scientist told me, they know what they're doing', the scientist says 'Well politicians, what do you expect, they don't know what they're doing'. And I call a politician a practitioner of policy. Doesn't matter, it's not necessarily party-based politics or whatever; it's government, an act, a practitioner of policy. So let's give a real-world example.

Ok, let us say, say we've got a fish stock that has attached to it; it has a whole lot of socio-economic drivers attached to it. It provides for jobs, it provides for food security, it provides for support industry, it supplies, might even in fact supply for government stability, if you look at a country like Namibia where a large amount of its gross national product comes from fisheries resources.

So the scientist, so the expectation really is on policy side is that, to the scientist is, 'Give me the comfort to be able to operate and keep all these other balls in the air. All these things that really affect me as a scientist, I want my people to be, have jobs, I want them to have, have food security, and I want them to support me politically, and I want the country to prosper'. Now, these are all very good policy, or political decisions if one will, turn to the scientists and say, 'Well you five give me the science that justifies continuing fishing that supports all of us.' And the scientist comes back and says, 'Well on the basis of the fact', and gives a lot of qualifications, and says, 'Look, on the basis of the fact that the stock has had a bad year because there's global warming in the thing'. The scientist says, 'You've gotta halve your stock. Gonna have to halve your catch.' And the politician will say, 'Well, how good's the science?' and the scientist will immediately qualify.

That's, and this is a real case in practice. The scientist will immediately say 'Well it's not really that good because I haven't had an independent stock assessment, the fishery is not reporting, we've got an ah, illegal fishery going on here, we don't know how much it is, ah we know people are catching undersized fish, and we're not getting those, we've had a bad spawning year, so we've got all these uncertainties on us. So this is the best I can give you at this time.' And that basically demonstrates a case in point. Because then someone has to take a punt. It's nothing more than a punt. And the politicians will always punt on the side of basically maintaining a status quo or improving a status quo. And that goes to job creation, food security, and revenue, really. And that's a realm that's very often time-based, and it only operates over four or five years, which is the elected period of office of most political players. The scientist will say, 'Well if I had that much more information, I had this more time, that will all qualify, but I will take, I cannot do anymore harm to this system if I adopt a conservatory approach to it, ok.'

Now, I'm doing this in the management context because it's the easiest to demonstrate, there are other situations where you can find this kind of thing. Is a certain research justified, particularly if there's a huge, expensive research that is not immediately, the benefits are not immediately apparent. Is it justified?

You know, should you be spending millions and millions and millions of dollars, ah looking at the ozone layer when it's going to take you fifty years to fix it. You know, we know it's a problem, why are we spending all this money monitoring it, you know?

Um, oh well look at Einstein, he did all his thinking, he didn't need a multi sixteen kilometre nuclear accelerator dug under the ground in the Central Massif of France, you know, he solved all of the problems with his brain, you know, why do we need to spend five billion Euros on this thing. And that's, that is also part of the same argument; it's just a different, different context. And the more practical accountability in terms of an economic policy versus economic science argument is that the rewards or the outcomes are more immediate, and more discernable. They're much easier to argue and much easier to demonstrate.

So, I think that's, that's the point. In terms of political, socio-political tensions, again I think it goes back to the question of expectation. Again I sort of approach it from a fisheries angle, but you could approach it from a large number of others. There's an expectation that if you are on the outside looking in, science is used as a tool to block you from actually doing something. So for example, if you want to start fishing, and you're a coastal state, and you want to start fishing, you've never had an opportunity because you've never had infrastructure or something, or whatever.

Like Namibia there, you wanted to join the fishery, you couldn't, the science was saying to you, 'There isn't enough to go around'. The people that have historically been involved in the fishery are saying to you in terms of policy, we are now in a position we can't give up what we've got because we've got all this other baggage, this socio-economic baggage that we're carrying along with our highly-developed industry. 'Sorry guys, you're not going to be able to do anything about this'. So you get a lot of, certainly a lot of the more recent fisheries instruments to try to deal with this, like deal with you know, recognising the needs of developing states to have the capacity and whatever to understand the science, do the science, to have access to actually have the fishing fleets built for them and this kind of stuff.

So, it's there, but it's there in lip service in many ways only, so that's the first barrier you've gotta get over. And there's a lot of argument going on now in the fisheries world, for example on certification, on trade certification procedures, because what they're saying is well, you know, trade certification of products, or designations of status of stocks or so on is only being done in whatever way to keep the developed countries out. And science, because it costs money, because it requires a high level of education, and very often a high infrastructure cost in some cases, it's seen; it's often used as a tool in a socio-political tension. And if you start getting into the realms of technology, it's even worse.

JS: Did you mean, did you mean less developed nations?

EF: Yeah, yeah. Or developing countries.

JS: Keeping them out.

EF: Yeah yeah, keeping them out. And you know, when you come to technology, you know, a classical example from ----, which I always quote to people, and it gives you some idea of this, is that in justifying post the elections in 1994 in ----, in justifying the continuation of the Antarctic program. The case was made, that although the Antarctic program was essentially, the Antarctic was a political realm in which ---- was involved. The Antarctic program *per se* was producing more PhDs in advanced physics than the rest of ---- put together. Now the question that comes from that is, is that, 'Oh, well what do we want, highly qualified physicists, you know, they're no good to us because we don't have nuclear accelerators, we're not building an atomic bomb.' But these are exactly the kind of people; this is exactly the kind of scientific discipline that you need to keep your infrastructure, your telecommunications industry going.

And you know, the things that you're taking for granted, and even in many cases in ----, you're keeping your cellular cell phone network going, you know, your mobile network going, that kind of thing. Most of those people who have their PhDs in Antarctic science in physics from the ---- Antarctic program don't work in the Antarctic, and they don't work in physics; they work in the technological industry. So the idea that science can gear politics or gear things that are politically important, or socio-politically important, sometimes gets lost in this debate about science is for the privileged and only the privileged because they can afford it. And everyone else is being left out or is being pushed out because they can't afford it, and because they can't see a need for it.

So you know, that really winds up the tension really quickly, and it's, it's, you just need to see it, you need to see it in forestry practices worldwide. I mean, the expert arrives from UNEP, enter the Brazilian jungle and says, 'Stop burning hardwoods to actually make your fields', well you know, he's not going to live to the weekend, because nobody cares! And he says, 'Well do you know you're doing this thing on, this is what's happening and it's depleting the ozone layer, and contributing to global warming', and the response is that, 'Well I don't care! I have to feed my family, and you do very well, you've got a little apartment in Brussels and whatever you can afford, and buy all the food and petrol you need. And you don't need that. We do. You know, we need the food, we need the potatoes that are going to come out of the, what was once this jungle.' And I think, the insidious danger of that socio-political tension to me is that it's actually going to get bigger. The science-policy gap is going to grow between the haves and the have nots.

And I really honestly see that in a lot of ways in the future. As the ideas of, as the socio-politics become, politics become more and more tense, the science-policy gap is going to be used as a tool to say, 'Well hang on. We're managing; we're managing our forests sustainably. We are therefore going to be able to sell our stuff, and we're going to make sure that you guys who are not managing your forests sustainably are not going to be able to sell your stuff'. And then you're going to come, well there will be a quid pro quo eventually because you know, but I think it's actually going to aggravate what is actually to me a very very serious situation, is that you know, resources particularly, are particularly sort of basic resources, petrol being one of them. It's going to be more and more and more a, if you like, a red herring in that discussion, which is a purely socio-political discussion.

So, and I think, the science in some respects has a role to play in those tensions, insofar that a lot of, not a lot, but there is a core of science that says the purity of what the science is trying to achieve, the advancement and systematic formulation of advancement of knowledge really should not be questioned, because that justifies the ends. And it's only really been probably in the last 15 to 20 years that the question of public accountability has become more geared to what science is trying to achieve. And I'm not advocating at all, and don't get me wrong, I'm not advocating that all science is publicly accountable.

There is some science where the benefits are so far removed or so uncertain that you can't, you can never ever make them accountable. You can't say, 'Well only Einstein working in the patent office could never have been accounted for his science'; because, you know, but he wrote an equation that was essentially five characters that turned the world upside down. You know, that's what you've always got to be mindful of. So in saying that the element of social accountability in the science is an important element, but it's not the end or, of everything. And I think a lot more science, certainly if you look at science policy, in Australia or the UK in particular, a lot more science is actually being, if you like, marketed on the basis that there are tangible benefits through time that can be, again, a horrible term, benchmarked, that there are certain, it's not an open slather just to go away and think up all sorts of clever things. You know, you've got to be able to have some use for that.

JS: Yeah, earlier on, you mentioned science being directed by policy, and there is, as you were just talking about there, the benchmarks or outcome based science, there's a push, people talk about the silos between science and policy, and there's a push where some policymakers are saying that scientific research should be directed to the outcomes of policy. But the implication there is, of course that the science itself will be directed to financers that are suitable to policy, and so those benchmarks will actually be, give us the information you want, as you mentioned earlier. Is that an increasing problem, where science is more a tool to produce answers for policy outcomes, rather than finding results that may conflict with policy desires?

EF: Yeah, I mean I think you've, I think you've very clearly put your finger on the problem. If that is the case, then all the, some of the benefits of this kind of patent office, Einstinian science are going to be lost. And it, it's a question really in many ways of balance, and I think, you know, the balance between the science as outcomes based, and ah more and more of that's becoming outcomes based, is, it's how you, it's going to become a large proportion, but you also need to leave space where the outcomes are less defined. I think it also goes to the point essentially of how you define your outcomes. You know, if you look for example at the space program, then the outcome was to put man on the moon. That was the outcome. No one was thinking beyond that, was to get a man to the moon, and that had a political outcome. The political outcome was to outdo, for the Americans to outdo the Russians at a time of tension in political history. A time of world dominance contested in political history. But the benefits of the science that had to be undertaken were felt throughout the science community. I mean, you know, one sort of always classic example is of Velcro, you know.

But there are a lot of others; radio technology, computer technology, miniaturisation technology, life support technologies. All of that, you know, rocket technology, all of that, minerals technology in terms of materials and so on. All of that had huge, huge ramifications, so it's putting the outcomes in a way that allows the ramifications and the spread, and you know, is there any point in us understanding if there's life on Mars or not? My answer is probably not. Unless we're going to live there. There's really no point to us, you know, unless we want to prove someone in the writing their science fiction book was correct. There's really no point in us understanding life on Mars. But there is a lot of point if we want to understand life on our own planet. Because if we understand the extremes that need to be faced somewhere else, then it gives us insight into what we face here, in terms of whatever.

So you know, one can have the completely same outcome with two different ways of benchmarks of measuring it, and yet, one is going to be more pervasive than the other. I think that's the real art of it, and I think we, we're still finding that way, I think we, and it's being forced, and the science community has been forced a lot by outcomes-based science, such as you've seen in the UK and you've seen going through the Australian system at the moment, particularly in relation to what CSIRO is doing in relation to what the Crown Research Centre, CRCs are doing and that kind of stuff. So you know, how, the one other factor which we haven't alluded on and I really want to actually kind of separate the last two questions from the previous four.

The one factor, and it deals with all the others, is that the one factor that I haven't actually alluded to, is the question of management of risk. Its, and what has evolved I think, particularly in some of the resource sciences map, let's not have this discussion. Let's not have this gap between science and policy. Let the scientist provide on the basis of their insight and knowledge. Let the science provide a set of uncertainties, and the risks attached to those uncertainties, and let the decision-maker, now you can see why I wanted to make that division.

Let the decision-maker then be responsible for following one of those scenarios, or whatever it is, and let the decision-maker take the risk, rather than the science. Now this allows the scientist the comfort of knowing that, what they can, what the scientist is doing is nothing more than really taking the knowledge that is available and systematically applying alternative hypotheses or ideas to it, and providing some measure of outcome that has a risk attachment or a probability attachment to it. This, and that probability can be drawn on any number of uncertainty of knowledge, uncertainty of information, uncertainty of analysis, systematic uncertainty which is general if you like, natural variation or whatever. And that leaves a decision-maker in a far more difficult position, insofar that the other guy's taking a risk. So it does away with a lot of the policy gap stuff. Simplistic though it is, it doesn't cover the situations where the science if you like, the scientific, the outcome of the science is actually not that clear, in terms of pre-empting a decision to continue.

You know, I once stood up in a conference, oh it must've been nearly twenty years ago, and I'd had a discussion with the taxi driver in a place called Bremen in Germany. And the taxi driver in his broken English had asked me what was all this thing about changing, the ice melting. And I mean, that's twenty years ago. And he said, 'Why should we care?', so I gave him the full story, and at the end of the day, he said, 'Well if I was a politician on the basis of that, I would say, you know, everything is so uncertain and so unsure, but I would just continue doing what I'm doing.' And I thought, well that's a really good demonstration of the case in point. I think equally, and what he didn't say but what I said when I stood up and recounted this story, was what I said, 'When the science is taken into that policy for the decision to be made, the science must not raise an expectation that it is better than it is, that it has more, more certainty attached to it than it does.

And you know, the danger of that was, at the time a lot of science was getting on, oh we need to, we need to monitor long-term changes or the start of long-term ecological research programs in the United States. We need to monitor long-term changes, and because that's linked to a five year cycle we're gonna give you the answers you need in five years time. Well twenty years later we're still not closer. Well we're quite a bit closer, I mean we're now beginning to comprehend that climate change is a reality. And there's a debate on what reality that is.

Is it going up, is it changing positively, is it changing negatively, is it changing, what are the, why is it changing? And we're having a lot of debate, that's where the debate is stalled over, to the fact that it's not, you know, climate change is not a reality, it's a natural variation, is because we don't know why and we're trying to find out why. And you know, whether you're a believer or an unbeliever, it doesn't really matter. I mean, I happen to be a believer, but there's an element of faith in that step, that the science hasn't yet fully resolved. It will do, in the next couple of years I would think. But at the moment, there's still uncertainty and I mean, even someone like, like Al Gore will actually say there's certain things we don't know, but he'll say it in a way that says, 'We don't know them' but he'll take the conservative science route.

We don't know them, then do nothing, you know? Or at best, crank back so you don't make that a problem, hold back from it so you don't make it a problem. So I think that the decision-maker is beginning to have a much more responsible, I think, role where the decision-maker is beginning to now say, 'Well I'm serving two masters', because a decision-maker ultimately does serve two masters because a decision-maker is a person who should be the best synthesizer for the information both on the, on both sides of the gap.

Because they should be best informed on what the science isn't telling them, and they should be best informed on what the socio-economical political requirements are of that, are to allow them to formulate a well-informed decision.

And you know, in terms of that, I think the scientists have not done a particularly good job for all sorts of reasons, and actually, up until probably, maybe five years ago, have not done a particularly good job in trying to get to grips with the notion that while, that they're not going to fix this problem, the big problem. If you go back to something like climate change, in a five year funding cycle. And I think that that's been recognised, equally been recognised on the side of some of the policymakers where you see some of the money that's going into long-term research programs to actually understand. And I think you've seen most dramatically, because it happened in such a short period of time, you've seen that change in Australia in particular, over the last year or so.

You know, you've come from a complete situation where it didn't exist, complete denial to the fact 'yes it does', these are [what] the consequences are, and this is what's happening. And funnily enough, a lot of that input is coming from industry, which I think is just fantastic. Look, make no mistake about it, it's not philanthropic, they're not, you know, the industry's not doing this because they want to do this. They're doing this because there's a reality check that's coming, and say, 'Well, you know, this is a monster that we might have to manage at some stage'.

The sooner we get to grips with it, the longer term, it's going to be a little bit easier to manage, we hope. And that's the risk we're taking. We're gonna put our bucks in now, in the hope that it's going to make things easier later on, you know, it's a futures discussion. So, I think that in that regard, the polic-, the decision-makers have now been forced into the position which is going to go back to what I was saying, is to be forced into the position where they really do have to account on both sides. And I would say, almost at this stage, the science is doing its own thing. You know, it's chugging along with what it's doing, but in the case of global climate change, the industry has kind of pushed it a little bit more to the, to the decision-maker actually having to make the hard decisions.

JS: Ah, the decision-makers are often the politicians, and as you said earlier, they work on an electoral cycle, which means shove the issue possibly to the next person who has to make the decision. Like if you have the, half the catch, or well as the UK fleet has been halved basically, over the last few years, but of course that's shifted their efforts to Africa, so they're still getting the same number of fish, they're just reducing their Atlantic catch, but so, there's two aspects to it, there's decision-makers, their terms of reference, how they work, how does that drive their decisions in terms of long-term sustainability, or fisheries management?

And also, one of the common cries that come out, or calls that there's uncertainty and there's risk, but equally it's been pointed out a lot of times that decision-makers understand uncertainty, understand risk because the deal with it economically and politically all the time. So I'm wondering, you were saying that the decision-makers will have to make those decisions because they are put on the spot, but how does that sort of connect with the natural cycle and wanting to move the issue onto the next generation?

EF: Well I think, yeah again, it's a very perceptive question, and I think again it's an elemental sort of $64,000 dollar question. You know, if one looks at all the statements made on sustainability, it's for present and future generations. There's this kind of legacy of what we're going to leave behind, kind of thing. And I guess one can go right back to, say well, you know, it's the old question of the selfish gene in many ways, that you know, our ancestors, we want them to be top dog just as we are, kind of thing.

And you know, we're not, we, I think in some extents that that's a little bit kind of, what's the word, I don't want to sound derogatory, it's kind of a little bit almost naive to think that's what, you know, this is where we are, we've suddenly had a sort of awakening, a scientific environmental awakening so that everybody's going to do the right thing for future generations.

But I do think that what has happened is that the electoral cycle has become; the continuity between the electoral cycle has become a little bit more continuous. Insofar that the issues become perennial, and not just issues that go from five years to five years; issues that goes from twenty years to thirty years to forty years to generation times in fact. And that kind of has, kind of has another factor in there which is the whole element of, I think almost social accountability, and certainly in the western countries, I think. In countries, in developing countries it's very different because you don't have time for that luxury. That, that you know, we don't want to, it was quite hard to formulate what I'm going to say, but we don't, we don't want to be seen in the next generation as the one, as the response, as the reason for that generation failing.

Now, I'm not naive enough to think that this is going to make every sort of policymaker and every policy decision-maker do the right thing. It's not. 'Cause there's always short-term interests involved. Always. And the short-term interests are very simple to see, and they're not that... But I think the longer term interests are not, and I think the longer term interest is probably for the for the first time in human history, we have the global capacity to identify a problem that is not necessarily purely and utterly socially based. It's based on a, on something that's happening on the planet that we have been able to detect. And that's change, that's global climate change. So we've had to come up with this slightly different way of looking at it.

And the discussion goes, 'Have we done enough, or will we do enough', I mean, I think that's a very... I don't know, I don't know the answer to that. But what it is also saying is that we are starting to question the whole notion of whether our understanding and the cyclicity in what we do is actually relevant to this thing at all. And if it isn't, for God's sake, we're gonna have to try and do something that is. So we need to look at it as a slightly bigger way, and you know, I think that's exactly what someone like Al Gore was saying, is to say look, can I think about this, think about it in a different way, so there's been a little bit if you like, and I think it's partly also to go with the sort of scenario that I outlined where you were talking about the development of climate change consciousness in Australia for example.

That, moving from the denial to the stage where we've gotta do something, but I don't think we need to forget, and this is probably really quite sad to say, but I don't think we need to forget that anything in my view, anything that is done to address that continuity issue, will always be done in the interests of the party that's doing it. So you don't want to be out of the decision-making loop because you're in denial. You want to be part of that decision-making loop because if you do that you can then affect ultimate decisions in one way or another to suit, hopefully to at least better serve your own interests. And that's what drives politics, and that's what drives human beings.

Most human beings will not kill unless it's in their own self interest to do that. And you know, again, the decision to go to war is always taken on the base of 'is it ultimately going to serve my interests, or is it not?' As a politician, that's a decision that faces them. And sometimes it's a very easy one to get the answer to, you know, I'm having the shit bombed out of me, well then hell, I'm going to have to hit back.

But so, why do I want to go to Iraq? You know, that's not quite that clear. Iraq is certainly 'I'm bombing me' at the moment. But you know, maybe something else. I wanna secure prisons in the Middle East, I wanna secure access to oil in the Middle East, I wanna be a recognisable force there, and I need to be there for a sufficient period of time to influence those around me, to control something that I'm very interested in, and that really serves the interests of all my people. I mean that's why the decision was made, and there was a bit of you know, let's do better than Daddy did, that was also, I mean, don't underestimate that one.

But, nevertheless, I think the important thing is, you know, to go back to that, that continuity issue, I like to think that that continuity issue is getting more and more questions attached to it. And those questions are hopefully going to err on the side of making sure that any good that is done is carried through from generation to generation.

JS: So you're saying that decision-makers will please their electorate, or please their interest groups before addressing the science issues, or the, if there's advice that a fishery must be reduced to maintain the stock, the decision-makers' main driver is to serve the interests that serve them?

EF: They will largely. You will get courageous people who won't. It will largely. Although, you'll find some accommodation. It's ah, they will find some way of putting sugar on the bitter pill, whatever it is. Let's take a closer example which is one I think, is really to me, a really an amazing step forward. The notion that there's overfishing capacity basically in Australia, and there's an over-expectation in fishing, for fisheries, for sustainable fisheries within Commonwealth waters. So the government came up with the, with a buy-out option. We understand that fishing is in your blood. We understand that it's a socio-economically beneficial thing to do. But we cannot have everybody in the space.

So we are prepared now to spend whatever it was, it was a lot of money; $250 million or something, it might have been more than that. We are prepared to spend this money to buy you out, buy your fishing interests out, and give you some personal financial security, and hopefully maintain sustainability of our fisheries. And this is what they did. Now that was a huge political move, because it, the outcomes are not certain of that, even now, that there won't be something that'll influence the fishery. But it was the right step in the right direction, and I think it goes to how much is a country prepared to spend on R&E, for example? I think that's a very similar kind of decision; we are going to spend $60 billion looking at alternative fuels, for example.

We are looking for alternative fuels now, we're going to do this because this is ultimately going to stop our dependence on fossil fuels. We haven't got to that decision yet. But that's the kind of decision that needs to, that I think will ultimately have to be made, because I think, we don't have a lot of space to move in this whole resource, natural resource versus economic, socio-economic expectation story. I mean I think it goes exactly the same as to the issue of food security. You know, why are over 60% of the world, nearly 70% of the world living on the bread line? And I don't mean the socio-economic bread line, I mean the bread line, you know, full stomach bread line! Where, you know, the other sort of 20 or 30% are living, you know, a whole quantum ahead of it, you know, it's not because there's not necessarily enough food to go around, it's just in the wrong place where it's being grown.

You know, why should the apple crop in France be ploughed into the ground, you know? Again, all the kind of questions you can ask. Why shouldn't it be going to Somalia, or wherever it is? And there's the element, well no one's interested to send it to Somalia because it's just a bunch of savages killing each other, which is a really sick way of looking at it. You know, the boys that give me the vote, here in the Champs Elysees, those chaps down there with the cloth caps on driving their tractors up the Arc de Triumph, you know, full of apples which they can't sell. You know, so I'm going to pay them to sell them and put them in the ground. And you know, this is, I'm probably being quite cynical, but I do think that, going back to your question, I think the notion of not only the continuity but, the notion of what is in my interest, as a gatherer of votes, what is in my interest. It is always going to cloud the decision.

And you know, for example, where have the squeezes come, in, they're not a lot of scientists who are going to vote for me, but hell there's a big industrial complex that's going to vote to me, and if they're starting to talk on my, to say they're not happy with what's going on, then I need to start to listen. And you know, I think this is what's happened, certainly I think in the global climate debate; in Australia I think that's what's happened at the, these things have all come together on the same stage and, you know, it's almost being forced out of necessity rather than not. And I think the same thing's happening in the US. I mean, the US has again been in denial, and I think the same thing's happening there.

JS: I want to come back to the last question there...

EF: Yeah. Well, the dominant culture in marine resource management is an interesting one. I mean, as I said, I like these questions, and you know, hopefully hopefully through some of the incoherency I've given you a theme, which hopefully is logical. I've always viewed fishing, which is really the centre of marine resource exploitation. One can argue that there are other things, mining, deep sea mining, and that kind of thing, which you've already seen manifestations of.

You know, the deep mining is interesting that the law of the sea, you know, the law of the sea, the 1982 Law of the Sea Convention has a huge element of the goodness of mankind, or the goodness of humankind in it, with respect to deep sea resource exploitation; mining, basically. You know, it's got a whole system set up, it's got the tribunal, and it's all set up from the minerals regime and science and so forth. Because this is the place where a lot of the developing countries of the time, going back to the early 80's, were feeling, particularly the land-locked developing countries, were feeling they were going to be left out of the common benefit to which they really wanted, really wouldn't have any look-in later on.

But there's not the same thing and the same protection for that notion is the lip service to it with respect to marine resource exploitation, living resource exploitation. That's the preserve of the coastal states, and it's only when there's any surplus determined by the coastal state that anyone else gets a look in. So you know, I think the dominant culture in resource management is that it's a common resource and, on the high season in particular, but even there, there's a local common due that it's, you know, the seas are bountiful, the seas are inexhaustible, the resources of the sea. It's my right to fish them. And therefore, it's far, in my view, if there's a continuum; it's on the exploitation side of the continuum.

And I also have a, well, I mean I've spoken to a lot of fisher folk about it as well. I have a very strong view that fisheries are essentially a blood sport.

You know, maybe it's a legacy of the hunter-gatherer or whatever, but it's very much a sport, very much an industry that's based on a very deep-seated psychological perception in humanity. You only need to look at a child with a piece of string and a spark plug, and if there's a puddle in the road they'll throw it in and they'll go fishing. They'll play fishing. It's that primal. And that is also exploitative, absolutely.

So I do see that the dominant culture in marine resource management is there's always more fish out there. I'm not going to catch the last fish. There's always something else, and if I don't get there first, someone else is going to take what's rightfully mine. And that's a really, really difficult cultural gap. And that means that, I mean I'll go right back to the beginning; scientists are very very often bad politicians. You will not see scientists lobbying a minister or lobbying a decision-maker in the same way as you'll see a fisherman doing it. They just don't do it, it's not in their nature to do it. Look, it does happen, and there are always exceptions to the rule, but if there's an issue, and one can say, 'Well, the scientist is far more abstract in dealing with their interests than someone who is making money from that interest directly'.

Because, you know, you can always have another idea. You can't always make another dollar. I mean, that's the difference. So, you know, the culture in marine resource management is generally, I think, and that goes to a lot of decision-makers, and I'm not saying that the decision-makers in marine resource management are bad people; the pressures are that they are very often put into the position where they can only make a decision in the support of a continued exploitation, where everything is telling them, that that's not the way to go. And they're overwhelmed by the, as I said, we're going back in the beginning, by that, all that baggage. By the fact that their jobs and their future security and all these other things, these immediate, absolutely immediate needs attached to that decision that they're going to make. And it takes a very, very brave decision-maker to stand up and say, 'Right, I'm cutting this', or else a very, very serious situation, and neither of them are, you know, it shouldn't be that in either case. I'm going to have to stop fishing all this. I'm going to have to cut it by half, I'm going to have to cut it by three quarters, or else there's going to be nothing left. And very often it's left to slide. And you know, you see it.

You see it in every single situation. You will see generally the hard decisions slide. And every now and again a good, a hard decision will be taken, but in most cases, not. And I think it's just purely and utterly this, and one can put it, if you want a sound byte at the end of it, fish don't feel, you know. There's this perception, the fish doesn't care, why should I?

JS: Ok just to take a sort of side issue for the last question, which you touched on I think, the bit about how scientists don't make good lobbyists, or as opposed to say, fishing industry reps, there's an implication there that the decision-makers and policymakers understand the industry language or the industry needs. They're speaking their language, at their interests, and I mean, to sort of go to climate change, I saw an advertisement for in Victoria for a climate change policy analyst in the government. And they're looking for someone with a background in law and economics. They're saying a degree in law and economics or similar field.

So they weren't actually looking for a climate change analyst with a scientific background; they were looking for someone with a cultural educational background from law or economics. So, in the social sense, what would the dominant sort of culture be? I mean at its crudest you'd say, 'The fisheries, largest fishing industry owner is also the representative of the government at an international meeting', at its crudest, you know. So where would, where would you say that the, socially is the culture base for resource management decision-makers?

EF: Well I think, you know, I mean I like the point about global climate change analysts. There are very, very few scientists who make that step. And the ones that do are normally really effective, in my view.

Really, really effective. And I mean, I could count the ones I know on, I guess, you know, probably less than ten world-wide. One understands that the anticipated effects are going to be socio-economic or legal. And therefore the best person, you can do that. There's a wonderful, I'll try to illustrate it by an example. There's a wonderful book written by, a science fiction book, and I can't remember the name of it, but it's written by Robert Heinlein, and it's about, essentially a whole new school of philosophy and thought which is trans-disciplinary. And it uses a scientific approach to, across a whole lot of disciplines; science, law, I can't remember what the other ones were; there were about four or five of them. And the idea was that this, this was based on a level of consciousness within the brain which you had to find before you could actually reach the place where you could learn this, you could be trained in this form of thinking.

And I think to me, the question of integrating the cross-disciplines is a key one. And the people that I certainly have seen, the scientists I have seen who have taken that step are generally not specialists; they're generalists. But they're generally, they're generally very inquisitive people, and they have a very broad view of what science they do, and a broad view of where it fits in. So the guy who sits in a lab, looking down a microscope and documenting the number of, whatever, pupae that a bug makes, is not going to be the guy who's gonna make a step. But they guy or the gal who, may not be a Nobel prize winner but has a really good understanding of population dynamics or you know, buyer statistics, but is interested in a whole lot of other things, will be the person that will make that. And I actually think it goes down to education.

I don't think there is enough done to educate decision-makers, firstly in what, in risk management, you know, it's the same way as saying, the guy who is making the decision is not an economist in the fisheries management world. He might be a scientist, but he's not an economist. So you know, do I look for a decision-maker who's an economist? No. I look for a decision-maker who has an awareness and an insight into quite a number of disciplines. And that only comes through education. It comes through experience as well, to a partial extent. But it comes through education, so I'm all for resource management courses that integrate; UTas has one that does that, and the integration is done, I wish I could remember the terms, I was just looking at it the other day. You know, the outcome is how to work, one of the outcomes is work in cross discipline and providing information to decision-makers, cross-disciplinary information. Being able to systematically analyse data and information until you reach that.

So the integration capability is a really, really important characteristic, and it's one that we very often forget about, because what normally happens with a fisheries manager is he's either a scientist who's come through the ranks, and he's got nowhere else to go, so he ends up in the senior position, so he ends up taking decisions. He might be the worst person in the world to take those decisions. Or it's an economist who ends up taking decisions. And he may be the worst as well. Great economist, great scientist, but they've got no insight to each other's, what each other is doing. And the generalist is very often the one who's able to do that. So I think we could spend more time, and I think we're going to have to, as a species, if you like, we're going to have to spend more time on thinking across disciplines. And trying to take out what's really important. And again it goes back to the point I made about risk.

Understanding risk is central to decision-making in the natural resource management field, and it doesn't mean that you have to understand all those vast statistics that go behind it, but you have to get a common sense basis; you have to be able to sit down and say, well you know, it's almost an intuition, and I'm not arguing against science, it's almost an intuition, is that's a logical consequence of what I'm doing. If I do that and this happens, then that's gonna happen. And that's a skill. That's a skill that people need to be taught. The art of making decisions is a skill, just as is the art of being, just as being a scientist is a skill. Just as being an economist is a skill. And we don't train a lot of our decision-makers. We don't.

I, you know, you can have the top scientists, but you're never going to make them into a top management decision-maker. Equally, you know, whatever. And the really rare ones are the ones who understand the process, and they do it almost intuitively. They understand the socio-economics of it; they understand the demise of the fishing. They understand the needs of the science. They understand the biology of the animal concerned. And you know, as ---- says, I don't know if you know ---- now, but he used to be the permanent secretary in ---- and as ---- said, they needed a little bit of mongrel in them. They need to be able to lobby, those are the people who need to be able to lobby, if anyone does. I mean, you know, I think everyone should be able to have their say. No matter where it is, but those are the guys who should be able to influence.

They say, 'Look, I see this coming down, and I think this is going to go real pear-shaped unless I can actually get the right information to the right person at the right time.' You know, and work like that. So I, I think it's a real, I think we're gonna need more of these people. And you know, I don't know how you're going to train them, you know, a couple of us now are putting together a course for ----, and that's one of the things we're trying to do, and ah, we call it ---- , it will be, it's a course module. And this is what, exactly what we're trying to do; we're trying to get a group of, trying to get a course that's integrated across all the disciplines. And very often the only way you can do that is by role playing, by scenario playing. And it's quite amazing, I mean, the kind of things that you can learn from that, and that comes from a kind of experience, but if you're not fit to do it, it won't happen. Some people just don't do much, it's just foreign to them, they just don't get it.

-END-

GH

At the time of interview, GH was the director of a major Australian Commonwealth science research and policy organisation with an ocean science focus.

JS: Should I just run through the questions?

GH: Yeah, sure, shoot, go ahead.

JS: Ok, so how would you define the science-policy gap?

GH: Well, I mean you can look at it two ways, there are two kinds of gaps really; one is whether the science informs policy, and in order for that to happen, the science has to be in a form, or I suppose understood to have a, to have a policy context. So you can do a whole bunch of science that never enters policy, that wouldn't really be a science-policy gap because it's not relevant to policy at all, there's, for instance there's probably very little of cosmology for instance that's policy related; when you get down to something like natural resource management, fisheries, or conservation, then you, there's a whole bunch of science that might be relevant to policy. Now, the gap can exist for two reasons.

One is that the science doesn't exist; in other words there's no science that can help fill a policy, that it can inform policy or help fill a policy gap. Or there's plenty of science there, but it's not in a form that's accessible to policymakers. So there's two, two holes in that direction; one is the existence or otherwise of relevant science, and the other one is the existence or otherwise in science that's in a form that's understandable by policymakers. Now on the other side of the fence, the gap could be that policy is made either actively or, or unconsciously in the absence of science, so that the people make policy decisions without bothering to take into account, without even bothering to understand whether there's any science that might be relevant to them, or actively not taking the science into account because there are other policy imperatives or perceived policy imperatives that override the fact that science might exist.

JS: Mhmm. So if you sort of take the second case you were talking about, where science is interfacing with policymakers for management purposes, as in fisheries, what would you see as the main cause of the science-policy gap in that situation then?

GH: There are two. One is, 'Oh, well science doesn't give me the right answer, so I don't, I don't wanna take any notice of it'. And in that for instance, has been the history of many fisheries around the world. So there's that kind of, that kind of science-policy gap. Or the other, which is usually more common, is that scientis-, that policymakers don't understand what science is actually telling them, and scientists can't actually convey to the policymakers what it is that the science is telling them. And that's a, that's sort of that's really a communications issue. The science might be there, but it's not being, it's not being passed through or presented in a way that makes it relevant to the people that are making policy.

JS: Mhmm. So can you give me a real world example?

GH: A real world example of that?

JS: Yeah.

GH: Well I, I think it's really hard, let me, let me, I'll try and think of one that's sort of topical at the moment. Well look, put it this way; I think its taken people, in climate science, for instance, or do you want me to go do one directly related to fisheries? But in climate science for instance, I think its taken people a long time, its taken policymakers a long time to understand that when scientists were being cautious about the predictions for climate change, they weren't actually saying that climate change wasn't happening.

I think that's a classic really. I think policymakers often take the very cautious prediction of scientists, as being, um, doubt, and often because you know, policymakers are usually wanting to make reasonably quick decisions, and they are usually wanting to have a series of facts with a capital F to back them up. And the reluctance of scientists to say, 'Well here's a fact that you can use to help your argument', is often misinterpreted as the scientist being doubtful and unsure of their own evidence.

I, in the fisheries area, ah well I think that it's really hard for policymakers to understand what, what the scientists mean when they say, 'Well the total allowable catch or the total sustained yield for this population is a figure somewhere between, let's say three tonnes and eleven and a half tonnes'. 'Well you know, why can't you just give me a number?' 'Well I can't give you a number because the statistics show that that's the range of figures that you get every time you run the models of it. Somewhere between three and eleven tonnes.' And then that's, that's also treated as being well, 'Why can't they give me a better answer that that, so let's pick a number right in the middle'.

And so trying to turn that into something that makes sense to a policymaker, and saying, 'Well ok, if you take the upper band of that estimation, you are being less precautionary than if you take the lower band. Trying to, trying to put those kinds of scientific predictions in words is really hard. So a part of filling the science-policy gap is having that kind of conversation so people understand; it's a bit like people have to understand what the likely impact of their decision is if they ah, if they make a decision on one set of figures, as opposed to a decision on the others. So getting, ah getting policymakers to understand that everything isn't black and white, is probably one of the hardest parts of that discussion. Does that make sense?

JS: Yeah, yeah, I was just thinking, if, it seems to me, I'm just following on from that, the science seems to want to present its data with the qualifiers of you know, probability, or confidence intervals, or just those sorts of errors, or qualifications...

GH: Those bounds.

JS: Those bounds, yep. But, what you read in the press might not be what policymakers see. It seems that economic advice or stuff like that is far more certain, even though it's often based on models and projections, but they seem to present the information as, you know, you'll generate this much revenue from this investment without the qualifiers.

GH: Well that's true, because in a lot of those areas you're only given one figure; I mean scientists are much more likely to give you the error boundaries around the predictions, whereas you won't find that if you read the front page of the newspaper or a feeder at the predicted rate of the predicted rate of inflation for 2009-10, you'll just see a single figure. Whereas the models might have given a range that's anywhere up to 100% of the value.

JS: So do you think there's a cultural thing operating here about how science presents data?

GH: Well, I think it's, it's scientists present data in a much more scientific way! They're, they know that the errors are real, whereas policymakers don't, don't necessarily need that much doubt.

JS: Right. Ok, now next question is, what would you see is the main socio-political tensions that is behind the science-policy gap?

GH: Did you say social and political tensions?

JS: Yeah.

GH: Aach, yeah I'm not sure that in a lot of cases, I mean I suppose it's social more than political, I mean, in a sense policymakers like to feel sure that their, that their decisions have a reasonable certainty of doing what they, what they're supposed to do. And in that sense, they're less likely to be, they're less likely to understand ambiguity. They'll want a figure, and they'll wanna base a judgement around that figure. Now, I suppose one of the things, say in the CCAMLR system, that's worked really well as a concept of precaution, whereas you can say, in the CCAMLR decision-making framework, you can say, 'Well, here's what the science tells us, but there's a fair bit of doubt around that, so in order to be precautionary, we should set a figure at least below this one.'

And, and there is, in CCAMLR, a long, I suppose tradition's not really the right word, but the working environment of CCAMLR allows that kind of discussion to be had, and for the idea that that precaution can be well below what somebody sees as being a reasonable number. That doesn't happen in very many other organisations. You look at Southern Blue Fin Tuna, or any of the other fisheries bodies, the whole political dynamic is to aim for the highest figure possible. And so you have, you actually have a very, a very different dialogue there; you're actually having a discussion about how to maximise your return, rather than minimise your impact. And so in that sense you got different cultures in different organisations.

JS: Ah right. Ok then, in that sort of culture and organisations, there's obviously the science community and the policy community, but there's the decision-makers. So how do the decision-makers fit into the play between science and policymaking in the science-policy gap?

GH: Well what's the difference between a policymaker and a decision-maker?

JS: Well, a policymaker makes or decides on policy and policy directions, but there's someone who makes the decision if that policy will go ahead, or make a decision about what direction that policy will go.

GH: Aaaaw, yeah I wouldn't draw that distinction. I think policy's made at all different levels. I mean, you can have a, in a sense ultimately, a policymaker is somebody that makes a decision, that actually has an impact on what somebody else does. And, and I don't really see the difference between the decision-maker and the policymaker. There's a difference between a policy adviser and a decision-maker. But all policy advisers is doing is framing a set of arguments.

JS: Right, ok.

GH: Do you agree with me or not? You're allowed to disagree with me.

JS: Oh yeah, yeah, just policy adviser is a new term. Haven't thought about that one yet.

GH: Ah, alright ok. See, if you think about it in terms of government, right? I mean, ultimately policy is made by government, not by bureaucrats. And bureaucrats are people that advise the government on the, on questions of policy, and say to other people, the chamber of commerce or the mining industry council or the ACTU; I mean there's a whole bunch of people that wanna play in that policy space, but ultimately it's governments that make the decision. Now if you take it down to the next level, I can make a policy here about ah, about the kinds of things that we might want to pursue, in the long-term in the Antarctic program, now I can make that on my own, or the government can override me, and say, 'Ah no, we don't agree with that, we think you should be doing this that and the other'. So it's really hard I think, at the end of the day, to make that distinction between a policymaker and a decision-maker. A decision-maker is somebody, in my mind, if you want to take this the step further, a decision-maker is somebody that takes a piece of policy advice and makes a decision in the context of that advice. Rather than the other way around.

JS: Mhmm. So there's a grey area?

GH: Very much a grey area. And a hard one to draw a boundary around, I would say.

JS: Right, ok. So going on from that then, in marine resource management, what do you think is the dominant culture?

GH: Oh! Well this is, this is actually interesting. I think we're starting to move away from a dominant culture. But ah, not, not very far away. And not, ah, not very far, and not very long ago. But look, the dominant culture in marine resource management, and you're talking about marine resource management here, has been the tragedy of the commons, really. The, the idea that, it's been a fair while now since people have, been able to, been able to mount the argument that the resources of the sea are bountiless, and that ah... you right there?

JS: Yeah, yeah. I can hear you.

GH: Oh right, ok. Yeah, you know the sea is all bountiful, and there's no, there's no limits to what you can take from the sea. It's been a long time since people have argued that, but the culture of access to marine living resources has been that of, of unfettered access to the high seas. And that translates itself into a whole bunch of behaviours, such as ah 'if we get in first with ours', in the absence of any internationally agreed mechanism for managing these resources, then no management is required. That all nations and all flags have the right to exploit the resources of the high seas, and that's meant that those that are interested in, in the very first instance, regulation, and then beyond that conservation, are always playing catch up to, to this sort of high seas rights mentality. And the high seas rights mentality is based on this idea that the resources of the sea are endlessly bountiful. And there's only been a few areas where that's been ah, for more than a few years has actually been challenged. And the CCAMLR convention's one of them, where the whole premise for, while it's still centred in international law, and acknowledges the law of the sea, and acknowledges the high seas rights of nations, it's still predicated on the fact that conservation is the primary goal of the convention itself. And that ah, and that ah there needs to be in place a set of decisions and rules that allow for the marine living resources to be managed.

-END-

IJ

At the time of interview, IJ was the Australian Marine Project Leader for a major international conservation organisation and was working in oceanic fisheries.

JS: Ok so basically I'm just trying to get behind the veil of the science-policy gap.

IJ: Yep.

JS: The sort of drivers, what people are, you know, influenced by in general. So you've got the questions there, so what's the first one?

IJ: How do you define the science-policy gap? For you, what is the main cause of the science-policy gap? How do you see the science-policy gap operating in practice? Ok, I wonder if it's probably easier if I just sort of raise with you some of the problems that I see, and then we can, 'cause some of it goes across a number of these questions.

JS: It'd probably; it'd be good if you could just, if you answer the questions, it sort of gives me a baseline to compare people's answers across.

IJ: Ok, sure.

JS: Then I can cross, you know, this person said that for this sort of thing.

IJ: Yep, yep.

JS: So if you, maybe you could run through that, and then sort of go into some of the general stuff at the end? Would that be better?

IJ: Sure, yep, yep.

JS: Ok, thanks a lot! Ok, so if you could just start out with the first question?

IJ: Ok, so how do you define the science-policy gap? Well I guess that the, the gap as I see it is the fact that you have, in many cases, now legislated or regulated, whether it be at the country level, regional or international level, structures that incorporate whether it be scientific advice, that is to be taken into account when management decisions, or if you like policy decisions are being taken, and how to manage, and in this case I take it we're talking about fisheries resources specifically...

JS: Yep.

IJ: And so that's, I would define, the gap is where, whether it be a binding process or a non-binding process, that science advice going into the policy or management decision framework is being ignored.

JS: Right.

IJ: So there's a mismatch between, if science is saying, 'You need to reduce a TAC for a resource', and that doesn't come through in the decision-making process.

JS: Right, so that's fairly clear. And the second question?

IJ: So for you, what is the main cause of the science-policy gap? Ah, that's a good question. I think the main cause is that there's a number of reasons. First would be that in many cases, it's a little bit like how national legislation considers stakeholder consultation; it's done on 'we will consider stakeholder advice', rather than 'it has to consider'.

And it's this whole problem, which I think is now a global problem within fisheries, which is about whether you take a non-binding or binding approach to decision-making. And more and more, within regional agreements, and particularly as they relate to bycatch or related species measures, they are put into non-binding arrangements within a convention, say, that for example, in an RFMO, quite often resolutions or decisions of the parties to a convention are non-binding, depending on the convention. And so, sorry I just have to, my computers gone into sleep mode, get the questions back! And so they're, instead of putting in hard binding regulations, often they're opting out for lesser measures that quite often are non-binding, but also they'll exclude, for example in the Western Central Pacific, where on a shark measure they excluded it applying to vessels under a certain length. And what that in effect meant was that 50% of the long-line fleet were exempt from the measure.

So I think, back to the question about what's the cause of this gap, firstly it's this binding non-binding relationship; the other is that I think there's a lack of willingness, well there's a sense of moving towards a very well articulate, articulated management procedure framework, if you like, in some of these complex RFMOs, but in actual fact, which is meant to take away the political influence or decision-making, when you go from the science to policy bit, but no matter what, a lot of these conventions are either consensus agreements, or they're a majority by three quarters or whatever, and it's very difficult getting agreement, and that agreement is not a base about having a very clear procedure that's only based on the science, it's still about political will to do so.

JS: Alright, and so, the next question?

IJ: Ah, how do you see the science-policy gap operating in practice? Well I guess it's a little bit following on from what I just said; you know, if you look at any of the, again, national, regional, international agreements for fisheries, I think that there are discussion, I think there are very good scientific discussions about what current catch levels may represent, but then when you measure it at the end of the day, and this is what we did with the recent ---- report that we produced, to us it showed that well, you know, there is a general lack of accepting that advice. Also, if I look back, I've been participating in CCSBT, which is the Southern Bluefin Tuna Convention for fourteen years, and there has been all sorts of scientific advice go into that commission, which has not come through in management decisions, and in retrospect it was always that the stock assessments, well probably did reflect how poorly the stocks were behaving.

Yet despite that knowledge, the managers had still not changed TACs at all. And to me again, CCSBTs a particularly good example of where, it's only in the last year that it's been, well two years, there's been changes to the TAC, which was predominantly based around the fact that science has been saying, 'Look, the stock's really in trouble', and secondly, that it was demonstrated that Japan had been catching twice the level of quota, legally, that/than it was allowed to. And they were basically put into a place where no longer they could just sit on the same TAC from year to year to year, ignoring scientific advice. But one has to remember; the change in that TAC was not based on scientific advice; it was based on the fact that Japan had been caught illegally fishing. And it still does not represent what you would measure in a management procedure sense, as going from the policy being directed by the scientific advice.

JS: Right, ok. And the question after that?

IJ: Ah, which real world situation can you give as an example?

JS: You probably answered that.

IJ: Ok. What main social political tensions do you think are behind the science-policy gap? Oh, I think it's obviously that, you know, in the last ten years, if you look at the behaviour of the distant water fishing nations, I mean they've seen it, that there are conventions being created, which are very much like a giant pie, if you like. And if you don't quickly get in as a party to some of these conventions, then you're not going to get a slice of that pie. And so for me, it's, a lot of the political will about what's been happening, in the first case, it's about locking up resources so that they can ensure an allocation.

If you look at the situation in most conventions, it's very unclear how they accommodate new and potential entrants into those fisheries, to give them an allocation. The other thing is that once they seem to all be in this RFMO process, and if you look at the decision-making that then occurs when an allocation is made, that's a very very difficult negotiation. Again an example would be CCSBT. There is no formula to work out who gets what, in an allocation sense. And so there's, if you like, a political will not to change too much the TACs at the moment, until it's agreed how the formula will not so much impact in current reductions, but when you have a recovery of an impacted stock, who gets the first cut of, in you know, the increase in quotas?

So I think there's, excuse me, that social political tension. The other issue is that, Western Central [Pacific] is a really good example of, if you look at the geographic area that's being fished, it's predominantly under the EEZs of the 22 South Pacific islands. And there's only a very small area in the middle that's high seas. And so the social political tensions if you like, is well, you've got science that says, 'Well look, Big Eye [tuna] and Yellowfin [tuna], we've got to do something about the overall mortality that's occurring in the fishery'. And then again, it comes down to an allocation issue. There has not been any allocations within that forum. And how do you account for the political and social issue of developing countries, where a lot of the fisheries within there are EEZs. And so for example, if you look at Kiribati. For now, their, they have paid access agreements with foreigners.

How do you accommodate the fact that in the longer term, they, Kiribati might have a real interest in developing its own fishery for that? And so there's a tension again about 'Ok well look, the science says you've got to do particular things for the fishery, but how do you allocate that across the interests of different groups and countries within that area. So there's a real tension between the distant fishing nations, who aren't fishing within their own EEZs; they're either fishing on the high seas, or in other participants in the convention, their EEZs.

JS: Ok. And the next question?

IJ: Ah, how do the decision-makers fit into the play between science; how do decision-makers fit into the play between science, policymakers and the science-policy gap. I'm not sure I understand the question, 'cause to me the policymakers are the decision-makers.

JS: Right, ok. 'Cause I was thinking in the context of, ah the scientific information goes to policymakers who are working within, you know, the frameworks of different conventions or regulatory systems, as in the Australian context, and ah, the decision-makers are the people who, you know, the policymakers will forward their recommendations off through say, the secretary of DEH, or the secretary of other organisations, and it goes up to the ministerial level.

IJ: Ok, um...

JS: And decisions are made, not necessarily down at the management, where they're just deciding on a day-to-day basis, but...

IJ: Yep, I think, I guess I'd interpret this question more to be about Australian national processes, rather than regional and international. How do the decision-makers... so you mean at the ministerial level then?

JS: Yeah.

IJ: It's a good question, because one of the problems we've always had is that the level of ministerial discretion that's given is quite often too much. And for me a perfect example would be you develop legislation around particular policy, ok? So it might be you have decided that you will have an endangered species act. That allows for the nomination of whatever species. Now, nominations are made, and they might be fisheries, fish that are caught in fisheries. And then you have what's called an independent scientific committee that reviews the information into that. They make a recommendation that's considered by the department that is then put up to the minister. And the problem that we've got is that, or I've got, is that, a while ago we wrote a paper about the precautionary principle and how it's incorporated into Australian legislation in EPBC act, and also within the Fisheries Act.

And there's different levels at which precautionary principle needs to be considered, and it's interesting because in this case, the minister, the department, needs to consider the precautionary principle when providing advice to the minister on a listing proposal. But then the minister doesn't necessarily have to take that into account. So there's that level. The second part is that the fisheries, if you look at the scientific committee recommendations from EPBC, the advice from the department and then the ministers' decision, they don't link; there's a big gap.

And there's in my mind, too much discretion given to ministers to make those decisions, ok. And another part that I'd say is that, what's intriguing is that, a good example of I think really good policy setting in the last year has been the harvest strategy policy, as it relates to fisheries in Australia.

And the main reason; there's probably three reasons for that for me, that it's such a good model, and of course at the end of the day, it's going to be a few years wait to see if you've got measurable, better management of fisheries. But it's because the harvest strategy is based around, first and foremost, putting in a framework that takes away an end political decision at the end of the day. So in effect, with your question, it takes away a decision-makers ability to rule on it.

It comes down to, initially, the policymaker making a decision that says the harvest strategy policy is going to do the following, and then at the end of the day when you put all the numbers in, according to what the policy framework has said you're measured against, whether it be 1.2 MSY, other targets and limit reference points are put in there, well you can't mess with the outcome, because it's like putting, it's a bit like *Charlie and the Chocolate Factory*; you put something in at the start, and depending on the ingredients you put in at the start, in other words the healthier your fishery, it's going to come up with an answer for what you have to do in a management sense at the end.

It's meant to take away the ability of political influence, whether it be by different stakeholders, on that decision-makers' ability to change the outcome in the policy framework and the advice of science-makers. Sorry, does that make sense?

JS: Yeah, yeah it does.

IJ: Ok, the other parts of why I think that's a really good way to develop policy and hence, outcomes for management incorporating science is that it's based around precautionary management. Where in cases you're limited by the amount of data you have to make a decision. So if you have a limited amount of data, you're more precautionary. And I think that's a really good way of looking, how you move away from this policy gap. And again, I'd say, look what's going to happen though is at the end of the day, we're going to have to see if that's worked. And for me, when I look at the moment about, well I think we've got to be fair on the South East Fisheries.

I mean, they've been one of the first ones to start looking at, through a tier system how make decisions on setting TACs. When I look at Eastern Gemfish and School Shark, with the scientific process they've gone through to say, 'Oh ok, they've done relative biological catch limits', so they've assessed, well what is the amount that they think can be caught of those two species, in particular fisheries.

And they both came up with a zero, ok. But despite that, there's this bizarre, in my mind, gap that has happened, where a bycatch TAC is set, way in excess of zero, but it's because it's part of a bycatch fishery now that they have ignored the scientific advice in this framework they've created, simply to accommodate other target fisheries staying open. And I think there's a real problem gap there.

Another issue is that previously, and if I think back to ten years ago, I approached AFMA and said, 'Look, we think you have to shut down the Eastern Gem Fish fishery. There is a Mirror Dory fishery that is a bycatch, supposed bycatch fishery that is catching Gem Fish, and, we know the time of year they're catching them, and the depth at which they're catching them; we think you need to instigate a depth closure and time closure for that fishery to protect the species.'

The response I got from AFMA at that time was a question back to me saying, 'Do you want to shut down this- make all the fishermen go broke?', and of course my response is, 'Of course I don't want to see the fishermen go broke, but they will go broke if the fishery collapses', and what happened? The fishery collapsed. So in my mind, it's a sort of, there is a tension between, if you like, competing, I've forgotten the term of the AFMA act, certain priorities are given to you know, social factors, environmental, and to me, AFMA has to manage according to the resource, and take into consideration up to a bit, but there should be a priority given to that.

JS: Mmm, well it's similar to the EPBC, where if you look in the preamble, what the purpose is, one of the conditions is that the minister must, I think the quote is, 'the minister must consider social and economic factors in their decision'.

IJ: Yeah, yep.

JS: So it's sort of like a door, you can do all this stuff for environmental nomination and protection, but at the end of the day, the minister must look at the broader picture.

IJ: Yeah.

JS: In that sense.

IJ: That's right.

JS: So is there another question?

IJ: Yes there is, let me find it. Just looking, so that was, 'How do decision-makers fit into the play', right, 'What is the dominant culture in marine resource management, and how does that affect the science-policy gap?'

Yeah, that's interesting, isn't it. I mean, it depends, I think the culture's changed a bit over the fifteen years I've been engaged in this area; I think it's changed very much to, firstly I think there's been a number of influences over the last fifteen years about, about the culture. I think there's been a change in the culture which affects the science-policy gap. I think there's a lot better and available information on the status of fish stocks, which a lot of it has really come about from the BRS reports, I don't think there's any ignoring that.

Which is one reason why we really want to see the states incorporated into these BRS reports, and much better cooperation between states and Commonwealth, so that the resource owners, who are the population of Australia, can see how their resources are being managed, so I think there's that, and I think that's had an enormous influence on the ability for ministers to just go ahead and manage according to how they would like and not be accountable. The other thing is that a number of policies that came in probably eight years ago, like the different oceans policy, bycatch policy etcetera, I think has really put on the table for a long period now, the direction that fisheries management has had to go in Australia.

And I should clarify; I don't, I think it's very easy to blame the actual commercial fishing industry for anything that's happened, and I don't, I don't see that they're a problem. I see the problem is that from the word go, when the Australian Fishing Authority changed to AFMA, it, it went on a long period of cooperation with industry, and what that meant actually, in my mind was that the hard decisions that had to be made about restricting either access or catches in fisheries weren't made because the partnership was too strong between the two, and there was a reluctance to make really hard decisions that were going to impact on industry. And so instead, what was done was, if you like, more like encouraging, putting in place certain controls on fisheries that should encourage unprofitability by some sectors in the industry, and therefore move out, get less effort in the fisheries. And it didn't work. And I think we're now in a stage where there's acceptance that we have to, it's no longer a God-given right to go out and fish. It has to be done in a certain way.

What I am concerned about though, at this very moment, we've got harvest strategy policy, we've got a number of efforts on ecological risk assessment, and therefore how you move that into ecological risk management for fisheries, but a lot of the communications that now again are coming out from AFMA, is all based around partnering with industry to make sure there's least impact on industry, and if anything else, there's growth in the industry. Instead of us hearing the statement that AFMA is there to manage the resource, we are getting communications coming out of AFMA that it's, that AFMA is all about protecting the industry. And I'm really concerned about that at this stage, and wonder whether we're about to see a change in culture, or whether it more reflects, the, if it more reflects the senior management of AFMA, and how they want to deal with it. Because it seems a gap between what we're being told at a policy level, and what we're being told by senior management within AFMA.

JS: So, to draw on some of the previous answers, ah you talked about scientific advice being ignored.

IJ: Yep.

JS: And you talked about a lack of political will.

IJ: Yep.

JS: And now you've mentioned, essentially, a culture of 'economy first'?

IJ: Yep.

JS: So in terms of the decision-makers, what sort of viewpoint, what sort of, what's their main concern, do you think? What's their main driver, in terms of managing fisheries?

IJ: Well look, I think, it's more I'm raising this as a question. I mean it's quite clear from the legislation perspective, and the policies that have recently been put in place, that it's all about having to deal with the fact that, if you look at the BRS status reports, there's been more red pen used every year. And that's the way the policy has gone. At the decision-making level, and I can only go by, if you like, up until Christmas, you know, we've had a change of government, and it's very difficult to judge the decision-maker if that's the minister. I don't, I don't, there's no way of judging what the current ministerial position is on this stuff.

All I can reflect on is what's coming out of the bureaucracy under that decision-maker is very weird wordsmanship, if you like, on what's going on, in relation to those policies. So it's, and

I can't tell whether that's a change in commitment to the policies, but I don't know if this makes sense, the way I see it is you have this overarching policy of how the bureaucracy should be moving forward, if you like underneath that policy, and above it the minister should be directing down to support that policy framework.

JS: So...

IJ: We haven't heard from the minister much about that, all we can reflect on is what's coming out from this bureaucracy under it, and to implement it. And it doesn't seem to match at the moment.

JS: Match the policy?

IJ: That's right.

JS: Yeah. 'Cause the previous, I'll go back to what you said in a second, 'cause you mentioned the minister directing down into the policy, to direct the policy direction, in a sense, and another interviewee said that the senior levels of management inside fisheries organisations and bodies are very sensitive to the political needs and desires of the minister.

So they tend to play towards the strengths of what the minister is desiring. And from what you've been saying, it sounds like they, they're very sensitive to the idea of economic development, versus conservation.

IJ: Yes, look I really wouldn't have a clue on how they play to the minister as such. I mean, I just don't know. That's very hard to measure, but what I think is, and so there's no way I can conclude that that reflects what the minister is asking for; I don't know. All I can say is that I'm worried to see demonstrated commitment of the policies that were last year adopted. And I don't know if that comes from a nervousness of there being a change in government, where the previous government is the one that has adopted, or been responsible for the adoption of those policies, the strategy policy. And I guess I just haven't seen a recommitment, if you like of the current minister to say, 'Yep'. Look, I'm assuming that's what's going to happen; that I think what you've got to understand too, is that it's a little bit, it's more almost like the style of communications coming out of AFMA has changed slightly in the last twelve months.

JS: In what direction?

IJ: Well, in terms of favouring industry development. Talking less about how we have to resolve the problems in the, so don't get me wrong, I'm not saying that they're not dealing necessarily with management decisions, I just think it's, that there's almost like a slightly different communications plan coming out.

JS: But they're favouring economic development over precautionary principle, or?

IJ: Yes.

JS: Right, so ah, in that terms if you sort of, to try to cut it down to black and white, would you say that the priority for fisheries management is increasing in developing fisheries and not losing fishing capacity, even in the face of scientific evidence to say that fisheries should be reduced or closed?

IJ: Ah, I don't think I'd say it that way. What I'd say is that, you know, to me there's still you know, an incredible reluctance to work, to be very hard on industry and restrict them when scientific evidence shows to quickly move on it.

JS: Yeah, would you say that's because of the political power the fishing industry holds, such as it is?

IJ: Look, I don't know why. And I mean, that's a really hard thing to try and understand why, anyone moves very slowly to restrict something; I don't know whether it's because hopefully, you know, someone else can make that decision in a few years rather than me. You know, do you know what I mean? I think you could think of an enormous list of why, if you know you have to reduce the catch of something, you put it at such a low rate that it's hard to measure whether it really does anything or not. Who knows why.

It could be, the other problem that I have is that, you know, a lot of focus for fisheries management in Australia is also put on the commercial industry, in the absence of really considering properly the impacts of recreational and game fishing interests, which you know, for me if you look at particular, well depending on the fishery, we're probably more thinking about neutral fisheries. You know, you may be considering a much, much, much bigger problem; being the recreational fisher.

JS: Yeah, 'cause here in Tasmania, they had the flathead season come open recently, and I sort of looked at it quickly and worked out that they were taking in excess of one million flatheads. And you're thinking, what exactly does taking that number of fish have on the estuary ecosystems and the coastal ecosystems. It can be quite significant.

IJ: Well see they are, it certainly can. I mean, you look at New South Wales, and there's a very weird political situation where the recreational sector is incredibly strong at a political level, and has influenced greatly the buyout of commercial interests for recreation.

Now, I have no objection to that, I mean that's all about how you allocate across different interest groups for a resource, whether it be for tourism, whether it be for recreational, whether it be for game fishing, whatever. I mean, that's, you know, to me, that's at a professional level, it's about sustainability, and so as long as you get the mix of that allocation right, well so be it, I think that's up to the general community, how you decide that. What I think is a bit of a misnomer, if you like, to do with fisheries management is that the only impact we manage for is commercial industry. And I think a lot of that is to do with, whenever it gets mentioned about recreational fishing etcetera, I actually think the governments and decision-makers have a lot harder problem restricting recreational fishing catch than they do commercial fishing catch.

JS: Yeah.

IJ: And I'll just add, there's another issue to that. Quite often in the types of consultations that I'm involved in, that are organised by government, they bring together what they call, you know, the stakeholder representation group. And there's two groups that are generally not represented there. One is indigenous take, where it's affected, and secondly is that the recreational representatives that attend are really only representatives of a small proportion of those people we consider true recreational catchers, because they represent the enthusiasts who join the club; they don't represent a family member who goes to catch a meal. And there's really a different representation happening there as well, when you consider a policy or decision-maker considering through, if you like, policy frameworks when you have a stakeholder consultation there's particular groups missing from that consultation.

And I suspect, see, the, I've heard the recreational fishers who come to these meetings refer to that other group, who are recreational fishing as killer fishermen. 'Cause they're not tagging and releasing, and again that raises another issue that's again not taken into consideration of this is, the whole thing of this farce about tag and release, you know, I mean, more and more sport fishing is about lighter gear, they play the fish longer, I mean, there is no scientific demonstration of how many live after they're released like this. But again you know, I think, again its all how you consider in the prop- management framework at a resource level of taking into account all the mortalities.

JS: Well, I've seen a few, mainly from South Australia and Victoria, there's I think three research papers put out on the survival rates, because there is that sort of, you know, hook them and send them back if they're too small, and measure them if they're undersize, but the mortality rates are in the 95% level. Because you know, of course, the hook destroys the mouth structure of the fish and, and that was the finding for bream and you know, some of the common recreational fishes, that 95, 97% of the fish don't live after they've been hooked and released.

IJ: That doesn't surprise me, and you know, that's really not taken into consideration generally, I don't know whether they have in those states, given those, those findings. But, does that sort of cover everything?

JS: Yep, are there any final comments that you think are outstanding, or?

IJ: Nah, look I think the biggest challenge for a lot of the work we do globally at the moment is a realisation; we don't need to demonstrate anymore about because, you know, I work for ----, and we ----. And we've spent a great many years ----, for example, ---- we've done a lot of work on. And there is no lack of information to demonstrate there's a problem. Everybody knows there's different problems, there's been a lot of discussion about what are the solutions to those problems, whether it be IUU, or a lack of ----, and the one thing that's holding it up is political will.

JS: Yep, and I'll ask you one question. What is that lack of will?

IJ: Well its self protection for a state's rights. And for a state like I said earlier, a cut of the pie. I mean the, countries are so concerned about that. There's also been a general, I think, locking up of discussion on some of these things, in what I would call process rather than outcomes, so it's very convenient to say, 'Ok, well look, we'll have a quick review of this, blah blah blah', what do you do about it? I mean, CITES since COP9 which was in 1994, has had resolutions and decisions about shark management and conservation. And that has included recommendations that the 172 parties to CITES should adopt so that they can better manage and better monitor shark fisheries. And there has been minimal uptake of that. And this is part of this thing of, we don't need to keep showing a problem with how much has been caught, it's actually working with some of those countries directly to try and change that will to adopt the measures that will do it.

JS: Right. Ok, look, thanks very much.

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KL

At the time of interview, KL was the Executive Director of a major Australian fisheries industry organisation.

JS: So basically I'm asking questions around the science-policy gap; which is research that is done and how that research is taken up in policy, or not taken up, whatever the case is. So, how would you define the science-policy gap yourself?

KL: How would I define the science-policy gap?

JS: Yeah.

KL: Um... I'd basically define the policy gap from the position that the policymakers are not giving clear direction through tight strategy about what they need done to inform policy.

JS: Uhuh.

KL: And quite often when they then des... can give clear direction, they don't clearly link the activities that are going to be undertaken by the scientists, through the process to ensure they're going to then, meet the needs of the policy people. So they basically ask a broad question of the scientists,

JS: Uhuh.

KL: And then expect that the scientists will do it in a way that will give the results to solve the policy issue. So there's not a clear logic, pathway between the research all the way up to being used in the policy, delivering outcomes at the end of the day.

JS: Ah, ok. And for you, what is, oh, some of these questions may be answered in the previous questions,

KL: Alright, yep.

JS: But, what is the main cause, do you think, in terms of how the science-policy gap develops?

KL: Ah, several main causes. One is that basically that the policymakers, and err including industry, are not clear about what they want.

JS: Mmhmm

KL: So they haven't developed good strategy, tight strategy.

JS: Mmhmm.

KL: They then don't work effectively to develop a logic pathway, from the research or the activities, all the way through outputs to next users to outcomes; to ensure that they test what they're going to do is going to work. So from that side, it rests with the policymakers. So they're unclear about exactly what they want, and then they don't test to make sure that what's delivered by the scientists is going to meet their needs. And then the philosophical blockage within the scientists, you generally wanna do the science they wanna do. So even when the policymakers are quite clear, the scientists want to go off on their tangent, that they want to answer.

JS: Yeah.

KL: There's sort of effort needed on both sides to solve the problem.

JS: So how would you see the science-policy gap operating in practice?

KL: What do you mean, operating in practice?

JS: Ah, well, in the real world, what sort of, how do you see it functioning? You might have already answered that, but...

KL: Just making clarity around what you mean by your question.

JS: Yeah, in the real world, how do you sort of see it actually functioning, there's the idea of what causes it, but how do you see it...

KL: Oh, ok. How to resolve the issue?

JS: Yeah.

KL: Ok. The reality is the policymakers need to put a lot more effort into their planning.

JS: Mmhmm.

KL: With stakeholders, they need to work out what they need in regard to their fisheries, where they want their fisheries to go.

JS: Mmhmm.

KL: And therefore how they're going to get there. Now that needs to be not motherhoody, it needs to be very tight. You might have a longer-term view, which is probably a twenty, ten to twenty year view that can, that has to obviously be a bit hazier, because it's looking at... a long way, and the further out you go, the hazier it's gonna get. Then when you get down to about the four year level, you had to be very tight. You need to know quite clearly where you're going to go and how you're going to get there, and that then needs to inform your investment into science.

We get to the stage where we know, where the policymakers know what they want, they need to then sit down with the scientists and the stakeholders and work out exactly what pieces of work they need to do to get there. And we use a thing in ---- called 'a theory of action'.

Now, a theory of action links basically... just hang on a sec, I'll just get a bit of paper from my desk... a theory of action works through quite a defined process, and what that'll do at the end of the day, is it'll start at the bottom with resources, which is funds, staff assets knowledge, whatever you bringing to the table. It'll then define a series of function activities, and that includes research. And research will provide outputs, which are reports etcetera; we then need to look at who's going to use those, so make sure that the outputs are in a form that the next user is going to use. That'll create practice change, which'll give change in policy or inform in policy, so that it's good policy. And then that should be able to deliver the desired outcomes. They need to start working through that process so that there's no leap of faith in between the science that's performed and the strategic outcome they've identified that they want to achieve. And that requires a lot of front-end thinking and organisation from the policy people, and good constructive engagement from the scientists.

JS: Right, so what sort of real world situation can you give as an example?

KL: Well basically what we would be doing is, we're developing an initiative, well we're trying to develop an initiative at the moment, for ---- in regard to, ah aquaculture development of Murray Cod in the north of the state. We've sat down and decided exactly, ah, what we're going to try to achieve out of it, so the outcomes we've set at the top end of the day. We've sat down with industry and agreed that, uh, with the industry stakeholders are going to contribute to the work that we're doing, that they're prepared to contribute to that process, and that's an outcome they also want to achieve. So we've got a clear direction about where we want to be. And we sat down with them and said, 'Well ok, what do we need to do to get there?' Some of its policy, some of it's actually breed and feed of science.

There's actually social evaluations, economic evaluations and also marketing ev..., marketing to do. So we put all those into the mix and see, well ok we need to actually tie down these five areas before we can deliver that outcome. Ok, what do we need, to deliver in those areas? Ok, to deliver in those areas, we need to do this work, and the people who are going to use this work are ---- policymakers, overseas purchasers, users, or industry in the ---- of the state, etcetera etcetera. So we need to make sure the outputs from those work meet the needs of those people, who will then change their practices to deliver the industry at the end of the day. So by working through that process, we actually get quite a good logical pathway from A to B, and then we sit down, develop an initiative around delivering on that. Once we start delivering we keep working through that process and saying ok, is the science we're doing delivering the outputs to create the practice change we need? Yes it is; is the practice change occurring? No it's not; ok what's the problem? How do we fix that problem on the way through, so then use it as a way to benchmark the work all the way through, to make sure that we might have to twig it here and there, tweak it here and there to make sure we can deliver what we want at the end of the day.

JS: Right. Ok then, so what sort of main social-political tensions do you think are behind the science-policy gap?

KL: Social-political tensions?

JS: Yeah.

KL: It's this real, what's the way to put it? A couple of things, one is that scientists for many many years, particularly government scientists who are paid just to do science, they got to choose pretty much what they want to do; they knew they had a wage so they knew they had an operational income, and they just went and did what they want to do. That changed in the 90s, well probably the late 80s, but particularly the 90s and is no longer the case, we've got a very much, purchaser and provider system at the moment, or an investor-deliverer system if you want to use a bit of language. Ah, then you've also got your academic researchers who of course operate in different spheres of government scientists, it's more about base research and a bit more academic freedom. So sometimes you've got the difference in between trying to get them to do a bit of the targeted research as opposed to more basic research. So we're trying to swing the scientists around to say, well actually you've got to do the work we need done to deliver the policy.

JS: Right.

KL: And you've got the policy people who are used to being very ah... ad hoc in their processes. And very reactive and not very planned. So we need to actually get the policy people into the very planned position, do the front-end work but also be bound by that into the future. So where you've got your tensions in that process, is that past philosophical positions in regard to both groups about how they do business, and both have to realise there's gotta be a lot more structured, with a lot more front-end agreements about what's going to be done and then a lot more rigour around the delivery process at the end of the day.

JS: Alright, so how do decision-makers fit into the play between, ah policymakers and the science-policy gap?

KL: Which decision-makers are you talking about?

JS: Well, I'm talking, in the sense, like marine systems you'll have science outcomes, science research, and that feeds into policy that's made by policymakers.

KL: That's right.

JS: Very often it gets feed up to decision-makers, who are the ministers or the secretaries of departments and that sort of thing. So there's sort of another layer on top of the actual people...

KL: Well... that's part of your next users. So as you work up through your process, your science will produce outputs which are reports, or data, or something else. And your next users, they may be a fisheries manager, it may be a fisheries director, it may be a minister, it may be a secretary. So when we go to the next users, we need to make sure that what we're delivering is what they need to make the decision they wanna make that becomes into practice change. So practice change in regard to, ah, a minister, may be, the practice change may be a change in government policy that will then deliver the industry outcome that you want.

As you work up from resources to functions, activities to outputs to users, your outputs from your science may be a report, that will then go to the minister whose next duties is the practice change after that will be a changed policy, or an induction policy position, which will then deliver the outcome which is the next level up, which is what you want to happen for the industry.

JS: Right, so...

KL: You've gotta consider that all the way through in your pre-planning; what will they want, and that may be particularly if you've got a ministerial decision, you want to engage with his office at the front end of the day, make sure that you've listened to and are aware of his concerns and considerations, so you can give the information to resolve those, those concerns or considerations.

JS: Right, so you sort of said, ah, (*cough*), pardon me, you said that you need to feed up the information so they can make the decision they want; ah what sort of decisions do they usually want to make?

KL: Well...

JS: What drives...?

KL: The ministers either have a statutory decision under the legislation, or they create policy.

JS: Right, ok.

KL: So basically, it depends on the decisions… will be based around stock assessment work,

JS: Mmm

KL: But also economic, and social, ahh performance indicators with industry. So you can harvest close to the limit, but your recovery will be longer, but the industry might want a quicker recovery. So you need to put all those into the mix and then give ... so he can make a decision about it all. What the total allowable catch is. But it may be said in the policy position in regard to the regulation of an industry.

JS: Mmm

KL: That's policy position that may... you'll again need different mixes of both environment, social and economic analysis to make that decision.

JS: Right. Of those three, environment, social and economic, which one do you thinks' the main driver in decisions?

KL: Depends on the decision.

JS: (*Laughter*), yeah...

KL: The reality at the end of the day is that we work on a, in ---- we... is that we've sort of got three jobs. One is to skewer the research, the resource. That's about sustainability of the resource. So environmental sustainability, biological sustainability. The second one is to share the resource; that's to give it to the best uses of the resource, that could be conservation, it could be indigenous, recreational, aquaculture, commercial fishing. And the third one is to grow the value of the research, uh the resource.

JS: So would that, um…

KL: If you don't secure it at the front end, you won't have a resource and therefore you can't share it or grow it.

JS: Yeah, so in that case, in terms of decision-making or in marine resource management, ah what would the dominant sort of culture...

KL: You've gotta make sure that it's, ah, environmentally sustainable before you move on to stages two and three.

JS: Right.

KL: So everything is covered by... has a caveat on it 'cause it's gotta be environmentally sustainable before you can move into ... develop into it. So basically if the stocks are at a status where they can't be fished, for example, then no one gets them.

JS: (*Laughter*) yeah, so that would mean that it's um...

KL: It means that the share goes all to biodiversity and conservation and none to the resource developers.

JS: Right, so therefore the implication is that it's evidence-based science driven?

KL: Evidence-based science driven.

JS: Right

KL: Yep.

JS: So that's the main function of the whole culture?

KL: It's certainly an evidence-based system at the moment, and the precautionary principle applies, which is basically that you err on the side of caution, but it does mean that if you haven't got information you don't make any decisions.

JS: Mmm. So how would the decision be made under uncertainty then?

KL: Well you've got to allow for the uncertainty in the decision-making process.

JS: (*Laughter*) Yeah, yeah.

KL: So basically if we think that there's uncertainty in regard to the stock assessment, then what we want to know from the scientists is several things; we need to know the sensitivity, and what level of change, or what level of 'impacters' can it detect. The robustness, which is basically, the, if one sampling is a bit funny, how does that affect the whole result; from the science, for example? And then the uncertainty, so is there any numbers in here or any level of uncertainty once we do all the calculations for example in modelling, and how do we allow for that? So we need to understand that all the way through. So we've got a system that only detects when a 50% change occurs and your sensitivity is very low and you need to be very careful about it. If you detect when a .01% change occurs then your sensitivity is very high.

JS: Right.

KL: This is all the types of things you need to feed in. Now historically, scientists have tended to give a number and the policymakers haven't really been interested in the robust sensitivity or the uncertainty of the information. That's becoming a much greater requirement for scientists to be upfront about that.

JS: Right. Just in terms of yield is, the theory of yield, you know, there's a maxim sustainable yield, ah with the science, so are you saying to work towards optimal sustainable yields, or cautionary sustainable yields.

KL: Umm, there's a range of numbers you can work on; what we usually have in most of, oh sorry. Where we actually use it, a quota-managed fishery, for a quota-managed fishery in the management plans, we actually have a rebuilding target at the moment. So whatever we take, we'll allow the stocks to rebuild to where it will actually be more economically and socially... more economically efficient and socially efficient to harvest those stocks. So basically we can harvest them at a certain rate and know the stocks will still be in the future and it's not a biodiversity or conservation issue; but if we keep them at that level that's uneconomic for the fishery to keep fishing that stock, so we've actually got rebuilding targets in there. So we always consider the social and economic outcomes as well.

JS: So that means you might not lower catches, or you would?

KL: We may lower catches even though the stock is quite sustainable, so that basically... For example, the rock lobster fishery in ---- at the moment in the ---- of the state. We have a very sustainable fishery, because we have the stock across the state breeding twice before they get harvested.

JS: Mmmm.

KL: What we have at the moment is a catch rate per unit pot lift, so every time we pull up the pot we're getting a very low amount of rock lobster per pot lift. Now, it costs the same to lift the pot every time whether there's ten kilos or 0.1 of a kilo in the pot. So what we find at the moment is that because the amount of stock that's been taken throughout the year is so low that it's costing them basically more to harvest the fish than what they're getting for it.

JS: Mmm.

KL: So what we're doing is we're putting in rebuilding in place, and we're in a process of cutting the TAC now so the actual available stock for the fishery will get up to a level where they're getting much more per pot lift and therefore they're making money.

JS: So you're increasing the TAC?

KL: No, decreasing the TAC. 'Cause it needs to rebuild, the stocks need to rebuild. So at the moment they're only getting about .2... I can't remember the number. Say they're getting about .2 of a kilo per pot lift; economically they can't afford to do that. Because it costs them more to harvest them than what they're getting. We've just cut the TAC over sequential years from about I think 450 to 320 and leaving more stock in the water each year, so the biomass in the water is building up so that in five years time when they go out and fish, there's so many fish there that they'll actually be getting 1 kilo per pot lift. It's economically efficient. There's no sustainability concerns about what we were previously doing. There's plenty of stock in the water, there's plenty of breeding biomass, but they can't get enough in a pot to make money.

JS: Right, why is that if there's plenty, just out of curiosity?

KL: Because there's something happening, and basically when the size limit is set, so that the recruitment at a level that's not coming through as well as it should, so we're not getting enough into the biomass.

JS: Aaah right.

KL: The same thing's happening in the West of the state, but the upwell stopped for a couple of years so the nutrients changed and the water temperatures went up and all these things happened.

JS: Ah right, so it's physical changes.

KL: And a whole lot of other changes, not actually the fisheries impact impact.

JS: Ok, do you have any other thoughts about the science-policy gap?

KL: Ah, the major thing really is that is that the policy people need to get their acting into gear, and work out exactly what they want. And then work out what questions they want to ask, and once they're really clear about that, then work with the scientists about how they're going to answer them. Once that happens the scientists need to make sure that they answer the questions that have been asked all the way through.

JS: Yeah, but is that also talking in a common language?

KL: Common language is very important; it's also understanding the science is more than biological, it's social and economic.

JS: Ok, well thanks a lot ----, that was really good.

-END-

MN

At the time of interview, MN had recently moved on from working as a senior manager in a major Australian fisheries management organisation.

JS: So we'll just come to the questions firstly. Obviously you've seen them, and they've been a part of your work in science policy. So how would you define it from your own perspective?

MN: Yeah, I guess the way I've captured it I guess when I was thinking about it..... is the gap between, say the outcome and recommendations of marine research and the actual policy objectives or the final decisions, so by the managers or the policy agencies, so and there's two issues there, I guess is 'what is the policy' and the other one is 'what is the level of alignment between policy and the final decision'. And so I'd see the gap as being primarily the gap between the outcomes of say research, ample fisheries research and the final decisions, made in relation to that research. So there's two; I guess it's important to understand, you know for my purpose at least, is that there's two elements to policy. There's the policy itself and then there's the final management decisions that are made, you know to pursue the policy. And there's obviously at times some divergence between the actual decisions and the policy objectives.

JS: Right, so that's if, 'cause the next question is what do you see as the main cause; do you consider that the main cause or?

MN: Yeah. I think that, I mean I guess that's the general theme that I'm working on, so I think one of, there's several key ones that I've noted here and I'm sure there's others but one I think is a lack of clear policy objectives so, you know, it's very hard to have a tight connection between the science and the subsequent policy or decision-making if the objectives of policy or management are not particularly clear. So that I see in my experience as one key area. Another one is the nature of politics and electoral cycles and governance and the reluctance in the context of that for hard natural resource management decisions.

Those decisions often have a direct negative impact on business, and often have a direct negative impact on other stakeholders, say in the case of marine parks for instance, you know there might be... are we clear that certain areas should be closed up for conservation but the consequences of that on either business or tourism or other human use is negative, so that then makes it more contentious from a political perspective and I think that whole connection of political cycles and politics being, you know, the pursuit of voter satisfaction on a mass scale is one of the things that means that the final decisions are not always closely aligned with the recommendations from research.

JS: Yeah, that's a...

MN: Obviously one that probably a lot of people would identify, depending on their involvement and things. Another one, Jon, is that and I think this has left the case these days and perhaps in the recent past is that, that question of what is driving the science or the research, and is the research or science being clearly driven by management information needs or policy needs or government needs, or is it being driven more by the science or the researchers themselves, thinking about what they think is important, and what directions they think research should be going in, so sometimes in my experience there's a gap between, you know the directions that research is heading in and the actual management needs, and that can be either a philosophical issue, or it could be a lack of awareness on the part of decision-makers about what the policy objectives should be. Or it could be an over-zealous scientist wanting to pursue his or her own research interests, so there's all sorts of variations on that. But I guess it comes back to whether the research is clearly connected to the management information needs.

JS: Right. Ok, well we'll keep on with the questions, there's a lot of stuff there, but um...

MN: Yeah. I've got a couple of others, just two more which are not particularly... I think another key one in my experience is that there's often too much uncertainty in recommendations arising from research, so there's no clear answer. And that's partly a reflection of the nature of the beast, but it can also be a deficiency in the way the science is presented. Yeah, and it's not presented in the right currency, if you like, for policymakers or for decision-makers.

JS: Yeah.

MN: But there's a bit of a disconnect there. But they're the main ones that I've certainly experienced.

JS: Yeah, they crop up all the time. But even though we might be repeating ourselves a bit, but sort of just asking the questions that I've given you, 'cause you've partly answered some of them already, just gotta have that answer-response format, so I can compare with other results.

MN: No, that's fine.

JS: So how do you see the science-policy gap operating in practice?

MN: Yeah, I think, I actually think in my context, say in the Commonwealth fisheries management context, that things have improved in recent years, and this is I guess just a bit of background, but say something like, there's a bit more of a focus on these fisheries harvest strategies where there's much more defined management objectives and parameters for the level of uncertainty in estimate, stock assessment estimates and all of those sorts of things, so one of the areas where I've seen it, and I guess it still exists in my experience, is in say an international fisheries management context.

JS: Yeah.

MN: Where there may well be some pretty good science available to guide decisions on global TACs for instance. But the sheer difficult in getting international agreement to a catch level is a sort of a really good example of, at a macro level, of a gap in action, I guess.

JS: Yeah.

MN: And it's the sort of issues we deal with domestically, the issues are very similar in that you've got a bunch of interested parties or stakeholders and they have divergent objectives. And as a scientist or a manager, you've got to try and reconcile science with various objectives and come up with an agreed way forward. And that's just so much more difficult in an international environment. So I guess for me, the international management arena is probably, you know, certainly not the last frontier, but it's one of the most challenging environments in which to test that science-policy gap, if you like.

JS: Yeah. Ok, and um,

MN: Yeah, that in general, international fisheries I guess...?

JS: Where they're outside effective control.

MN: Sorry?

JS: Where they're outside effective control in many ways.

MN: Yeah, or even where they're supposedly within effective control of a regional fisheries management organisation, and yet there's a lot of politicking going on around, you know around sort of avoiding a decision effectively, even though everyone knows what they should do, self interest at a national level might prevent them from agreeing.

JS: Yeah, yeah that's fairly clear. So what sort of main social political tensions do you think are behind the science-policy gap?

MN: I guess you know it comes back to some of that earlier stuff but for me, there is a focus on the short-term objectives, whether they're political objectives or business objectives, so I think that definitely confounds the uptake of research if you like, and in the setting of, in a fisheries example, might be much better to set a conservative TAC and have a long-term income stream from the fishery, but that's going to happen over several electoral cycles, or several, or during the tenure of several different business managers or whatever, so it's that sort of short-term approach and I think the electoral part of it is significant, in that there's, you know in a classical sense there's only a short period of a year in any one electoral cycle where decision-makers are really willing and able to make difficult, longer term decisions.

And you know, when the election's coming up and things become I guess a bit more short-term focused, and more about influencing voters in different electorates, and that sort of thing. So I think and just that sort of here and now economic pressure on business, and you know, as a manager, or an ex-manager now, but you know, just the fact that in most bureaucracies, certainly within politics, there's nearly always much greater attention and focus on short-term pressures and short-term objectives and the expense of longer term strategies.

JS: Yeah, ok. So how then do the decision-makers fit into this play between science policy and science-policy gap?

MN: Yeah, well I think you know, there's obviously it can go several different ways, and the best way is that they provide an element of clarity in terms of objectives which then flows through into clearly targeted research and research outcomes that are clearly relevant to the management objectives. And I think decision-makers have a key role in ensuring that alignment, both in the commissioning of research and also in terms of their own understanding of their management in environment and the information gaps. And the less alignment there is, the more scope there is for the gap, if you like. There's also I think a bit of a, in terms of just defining decision-makers versus policymakers, so in say the AFMA example there's, you might see AFMA as the operational fisheries management decision-makers, setting TACs and implementing closures and that sort of thing, and policymakers are more at the department, you know, the DAF level, and say the inner more political environment.

So if you consider them, as they are in some cases to be separate entities with slightly different roles, then that can also contribute to, you know, less alignment if you like. So the way, if the policy itself is not particularly clear in terms of its structure or its objectives, then that gives the decision-maker a little bit more room or opportunity to diverge from, the sort of clearer policy objectives. So like in the example with the harvest strategy is that if the decision rules in the harvest strategy are fairly ambiguous or they're not very well defined, then that may give a decision-maker several different avenues to take, whereas if they're fairly clearly defined and the level of uncertainty is defined, and the limit reference point is clearly defined then that reduces the amount of sort of wriggle room if people are, you know, concerned about political implications or short-term issues.

JS: Yeah. What sort of direction does that divergence usually go?

MN: Oh I think, from my experience it nearly always goes for the more short-term immediate pressures, and often that'll be, you know, in sort of, in a government sense there's often more, more government awareness of the people pressures, so the industry, you know there's often a great awareness of what industries needs are, and less awareness sometimes of the longer-term consequences of making the wrong decision. And it's also, it's not so much making the wrong decision, it's just making, you know, making a less correct decision over time which ends up being a wrong decision.

JS: Yeah.

MN: That compounding of you know of, sort of less correct decisions, if you like, or less... decisions that are less conservative than they should be in the face of uncertainty... yeah. But I think if there's too much ambiguity in policy objectives or in decision rules in harvest strategy of things, then there's more scope for decision-makers to avoid making decisions in the long-term interest.

JS: Yeah. 'Cause earlier you said there was a trend or occurrences where the science was supporting the policy, or science was informing the policy...

MN: Yep.

JS: But those decisions have been ignored. Would that also in the case of the clear policy, or would...

MN: I guess so, but I think it can still happen, I mean, there can, I think, my recent experience is that politics can be very powerful in terms of influencing decision-making, and in a period, for example, just before an election, that can be, you know, very influential in terms of the sort of decisions that are sort of made or not made.

JS: Yeah. At what sort of level is these decisions being made? Is it ministerial, or...

MN: Oh, it depends on the issue, and the agencies and everything, but, you know right through organisations. You know, it can be at quite a low level or it could be quite a high level. And often there's good reasons for not making a contentious decision. You know, and that's unfortunate, that's just the nature of the beast.

JS: Yeah.

MN: But certainly yeah, there can be lots of reasons given for deferring a difficult decision, say particularly, you know, in a difficult period of an electoral cycle, or when a decision-making body is under a bit of pressure for other reasons.

JS: Ok, so just in general, what's, what do you think the dominant culture in marine resource management is? And how does that affect science policy...

MN: I think one of the key cultural issues or, it might even be a technical issue, is how do you, literally how do you manage in the face of scientific uncertainty, so there's in some cases an expectation that science will give clear answers to a problem, and it often doesn't. So, and there's a reluctance, I think there's a bit of a culture in the bureaucracy of 'if there's no clear answer, we won't make a decision, or we'll you know defer a decision, or we'll seek more information'. So that sort of managing in the face of uncertainty, particularly in the context of natural systems or fisheries ... real issue, and there's, you know, obviously things like the precautionary principle that were developed and enshrined to deal with that, but you know, being with limited kind of uptake I think, in actual fact. You know, there's some examples of it, but again it gets confounded by political cycles and pressures on bureaucracies and that sort of thing.

JS: Right. 'Cause one thing that I'll run past you is, you know, I've talked to a few people.

MN: Yeah.

JS: And I've also read some papers, particularly with in regard to IWC, there's a lot of stuff about how they're functioning and also in the EU Common Fisheries policy, but what I've heard back is that at the political level, decision-making at the political level, uncertainty is fairly well understood.

MN: Yeah.

JS: Basically someone sorta said they work with uncertainty all the time in terms of economics and policy and social outcomes. And the IWC papers were saying that uncertainty was used as a football; there was something about how they would seize on, and say, 'There's uncertainty here'.

MN: Oh definitely, yeah.

JS: So, when you're talking about uncertainty as an issue, is it a, a real issue in terms of, we have such large error bars, or is it more a political...

MN: Yeah, I think it's both, to be honest. Like I definitely agree that, you know, in a case where there is a lot of scientific uncertainty, then interested parties will use it as a reason to delay decision-making.

JS: Mhmm.

MN: Even though, you know, that's the opposite effectively of what the precautionary principle calls for.

JS: Yeah.

MN: But I also think, you know, I guess its all very well for decision-makers, and so they deal with uncertainty all the time, but I don't see a lot of examples where that precautionary approach is adopted fairly, fairly clearly, you know. It's something that's very difficult to deal with, you know. If you're making a decision that's gonna have an impact on you know, a lot of people or a lot of businesses, and there's no evidence, no real clear evidence one way or the other about whether you should do that or not, then it's a difficult decision to make.

JS: Yeah...

MN: So I think there's that pure element of it, if you like, and there's also that more the sort of lobbying part of it where lobbyists will certainly use uncertainty as a reason to delay decisions or seek more information and that sort of thing.

JS: Yeah.

MN: And I think, you know in some of that literature around the tobacco industry and some of their lobbying strategies, you know, they're really good examples of that sort of strategy being applied. I think it's obviously a fairly common strategy in natural resource management, where there are negative impacts on business and that sort of thing.

JS: Yeah, I've heard of it. And also just to, because there's different levels of, like in organisations, there's different levels of policy advisers and scientists, and they have different roles.

MN: Yep.

JS: The decision-makers, I was wondering if you could tell me where they're generally, where you sort of see them generally drawn from, what sort of level, and what sort of cultural background they generally have, do you think.

MN: Yeah, I guess I mean, it began, it varies a lot depending on the organisations. I mean, AFMA as an example, the key decision-makers are the board, and there's a board of directors like there would be in a private company, and they have a pretty diverse background, you know, both from a government sort of background, but also from an fishing industry background, a research background, a business background, so I think in general there's a pretty diverse make up, but there's no doubt that that certain elements of that have some key influence over the decisions, and that will vary, just depending on the issue and the background of those people.

In a government sense, you know, say in a large federal department like say the environment department, the decision-makers are I guess more mainstream, government-focussed senior executives within the department, you know, right through to the minister sort of thing, so they probably have a slightly clearer mandate, if you like, in terms of the sort of operational objectives of that particular department. So I think, you know, I guess, it's hard to, it is hard to find decision-makers in a sense, I mean in AFMA's sense it's fairly clear that it's the board, but the advice that the board gets is a result of obviously work from a whole range of different people, including management advisory committees and the industry members on those and the management staff within the organisation, so they all have a clear role in formulating the advice that the board then decides on.

JS: Mmm. Yeah 'cause I was talking to a former Premier's scientific adviser, and he was saying that the people he was talking to at that level all came through basically legal and economics backgrounds. So is that the sort of...?

MN: Yeah, no, that's not the case in my experience, like I think that there's significantly more diversity, say in the AFMA board.

JS: Right, yeah. So they're more based on the management industry?

MN: Yeah, representation of the key elements of the fisheries management environment, say, you'd definitely, you might, we've certainly had retired judiciary, we've had economists, we've had business people, we've had fishing industry people, we've had eminent scientists, you know, we've had, really the sort of classical connection of, or election I should say, of sort of subject-matter experts, really. So that's a pretty good model really.

JS: So that can balance off the business perspectives you were talking about?

MN: Yeah, although certainly in certain decisions, you know, one sector will hold sway over another, kind of thing, and again, that's very influenced, I think, by the government of the day and what they're sort of either clear or less clear policy objectives are.

JS: Yeah, and when you say policy directives, are you saying actual clearly enunciated ones, or more we're for business?

MN: Well both, and obviously they're not always clearly enunciated, they might be enunciated in the legislation pretty clearly, but even within that, there's quite a lot of scope for variance in decisions.

JS: Yeah.

MN: I don't have enough exposure if you like at the really high level to know about you know, the sort of written versus unwritten policy objectives.

But certainly I know that at certain times, you know there is a divergence from you know the black and white interpretation of legislation.

JS: Mmm, yeah that's often for political reasons.

MN: Yeah, and that depends on the, you know, like you know, like the period before an election's always an interesting one, 'cause there are definitely, you know, pressures and priorities that are not, always as they appear in black and white, kinda thing, you know.

JS: Yeah, it's not as if the public service, doing its regular job is responding to um... I was talking to one person who said that they, ah respond to the desires of the Government, as you were saying.

MN: Yeah, at times very much. At times that can be incredibly powerful.

JS: Yeah.

MN: And that's you know, what I was saying earlier, I guess that's one of the key reasons for a gap.

JS: Yeah. Right. Ok, look, thank you very much.

MN: That's alright.

-END-

OP

At the time of interview, OP was a senior marine campaigner for a major Australian conservation organisation.

JS: Ok, so do you have the questions there?

OP: And just one question, is this about marine science, or science more generally?

JS: Ah well, I'm focusing on marine science, 'cause that's where a great sort of gap is. In fact, if you want a bit of background on what I've done on my research, the science-policy gap only really shows up in fisheries and forestry. And the only other place I've seen it discussed is in early childhood care and heroin intervention in the medical sciences. So, it's not really generally discussed anywhere else that I've come across, unless you have seen it?

OP: No, no.

JS: So, is there anything else you need to know?

OP: No, that's fine.

JS: Ok, good. So, oh where are my questions... so the first question is, ah what is it...

OP: How do you define the science-policy gap?

JS: Ah, yeah.

OP: ...the questions you emailed me.

JS: That's the ones, yeah, unfortunately I'm late so I haven't had the chance to print them out.

OP: Right. Ok, in terms of the science-policy gap, how would I define it? Well essentially in the case of Australia I can only really talk about marine, marine science, marine policy, here in Australia is that at times policy may head up, I suppose institutional arrangements, planning processes, etcetera, which require a significant amount of marine science research, public good research to actually be able to provide the data and the knowledge to make really well-grounded decisions.

Often policy is, you know, the policy may not be that strong, it probably tends to suggest an outcome which cannot be achieved without really significant increases in resources going into finding out more about the marine environment. So I think probably in terms of the gap, it's basically where policy expects an outcome, but it can't be achieved because there is insufficient resources going into the science.

JS: Right, and you sort of mentioned public good research, as opposed to I suppose industry research.

OP: Yeah look, yes I'd like to separate those, because I mean obviously there's quite a bit of research which goes into whether it's the oil and gas industry or the fishing industry that's, they're sort of the main, the two main stakeholders who really put some serious investment into marine environments, and to some extent, they're also very closely linked with the fisheries research and development cooperation, which is a joint government industry thing which again ties pretty much any research to industry outcomes, and then there's Geoscience Australia which ties a lot of funding into outcomes for the oil and gas industry in Australia as well.

Now, a lot of that becomes tied research, becomes confidential research, I'm basically suggesting that we need to have a much stronger investment in public good, where we actually do good science which has public benefit, not just company benefit or industry benefit. Because at times, industry benefit may not be the same as social benefit.

JS: Mmm, exactly, and also, it's also using public funds.

OP: Yeah. And that's right. I think if we're going to have public funds used in this way, then we need to have complete transparency in the way in which it's used and the sorts of data which is being collected, and the release of that data, and to ensure that the research that's being done is I guess integrated in the way we should be planning and managing protecting the oceans, and ah, it isn't necessarily the case, I suppose. The other thing in terms of that gap is that, probably, maybe getting into some of the questions that fundamentally we have a real problem with research in the southern part of Australia, in terms of Southern temperate waters.

There's obviously a fair bit of policy around oil and gas and fisheries, because fisheries is, there's a strong involvement of fisheries in the Southern Ocean, in the southern waters, but we just have not put enough public research into getting a better understanding of what's happening in the oceans down here. And I think the outcomes in the south-east MPA process are a good example of where we... they were relying very much on surrogacy and some benthic data, but we had very little information about water columns and biodiversity, etc.

JS: And modelling.

OP: Yeah.

JS: Ok, so ah, just the second question?

OP: Yeah, the second one is 'how do you see the science-policy gap operating in practice?' Well I suppose I sort of touched on it a little bit, but basically if you look at something like the national representative system of marine protected areas, the RSMPA, Australia's supposed to establish an interim RSMPA by, well it's supposed to be by 2012, to establish a comprehensive, adequate and representative system under the current rate, we'd be looking at somewhere probably in the middle of the century before we actually do that. And so, this is a policy which has been generated at international arrangements as well, but it's also a policy which has been adopted by Australia's government, and also by state governments.

But we look at something like the South Australian government, they've been dragging their feet, they may have a system set up by 2010, or maybe 2012, but again, the policy is there, sometimes it's fairly broad and I suppose, motherhoody in many ways. But there is something, a kernel there, which requires governments to really do something and obviously they're going to interpret them somewhat differently, and so each state government and Australian government will interpret them differently. But the policy is there, and they actually have to get out there and do it.

Now, if the science isn't there, you end up getting what I'd probably consider what I'd consider being paper parks, where we have lines on maps which suggest that we, yes, we've actually done that, we've put a line on the map, we've actually got a park there. But it may not actually be in the right place, may not be enough of them, it may not have sufficient protection, you might get multi-zoned MPAs, which are sort of the flavour of the month here in Australia; we really need to be focussing very heavily on no take, but the difficulty is that when you have a policy to establish the robust system and you don't have the science, it's actually, in terms of conservation groups who rely on science to be able to argue their case, it's very hard to argue that case.

And so that means that industry stakeholders have a much greater influence over the result because they have their own research, they can actually put that on the table when they want to. We've never really, the cognisance of what that research actually is, and so again, if we had a much stronger public good research sector, particularly in the southern part of our oceans, then I think we, we would be able to get a better result in terms of marine protection.

But the environment sector is somewhat hamstrung, because they just don't have the available information. And the thing is, industry has limited information too, and uh, there needs to be a concerted effort in trying to breach the gap, by substantially increasing the amount of resources going into marine science. And so, just this last week, we've heard that Australia is now being given 2.5 million more square kilometres of oceans, under the UN Law of the Sea convention.

We'd applied for that some years ago, and now areas of Tasmania, areas of Western Australia, and even off Heard and Macdonald Island, they're now going to be within our responsibility. And even though we're not going to be able to use the water column, we'll be able to extract oil and gas from those areas, and also use the sea bed. So again it comes with a great responsibility, that we haven't really got to know yet. The other 12 million km^2 are part of our ocean domain.

JS: Yeah, just moving off onto a tangent, about marine parks, I think, I dunno if you saw there was a paper, came out in the last couple of months, I think in *Conservation Biology*. But I probably could send you a copy if you're interested, but they were looking at failure in MPAs, and they said one of the greatest failure was lack of enforcement.

OP: Yes. Ah, I guess I think that would certainly, it could, well there are probably examples where that probably does ring true. I mean, in the case of the parks, which are out in say the South East region, which have just been declared, most of the no take ones are so far off shore that no one would be going there, not even the oil and gas industry or the fishing industry; there's no fishing industry weren't industry nor the oil and gas industry, and so that's what became no take areas. It didn't mean that there were actually a lot of biodiversity out there that they were trying to protect; it was just because they were way out of the way, they didn't have any economic interests. And the problem is, economic interest has dominated the identification and selection of the parks.

So that's one of the problems we have, in terms of enforcement, in those particular examples, enforcement won't be an issue. However, when you get into places like the northwest shelf, and in say, the Coral Sea, where there's now considerable efforts to try and get greater protection there. As well as problems with, I guess, domestic fishing industries and so on, there's a real big issue in terms of fishers coming from our northern and western neighbours, wishing to do shark-finning and whatever, where the enforcement is going to be a big issue.

However, I'd argue that if you're able to crea- … establish really strong no take areas, which it's then easy to show that if someone's in there doing something, you know that they're actually doing the wrong thing, whereas if you have very complex multi-zoned parks, which you're never quite sure who's in, you can sort of argue lots of 'oh, we didn't know we were in that particular zone and so on'. And so you can actually say look, well actually, as well as being a biodiversity protection issue, which a border protection issue as well, that actually we need to be able to have, if we had coastguard or navy, they could argue, 'Well we're protecting biodiversity, not just protecting our borders'.

JS: Yeah.

OP: I think that's, and that we want to have conversation with our neighbours in PNG and Indonesia and so on, to sort of talk through these issues, because we see this as being an important thing in terms of global oceans protections, not just about trying to stop people coming into our country. There's sort of a lot of other reasons why we actually want to provide protection for these areas. And that's where I think, ah, enforcement is a big issue, because as you get further off the coast, it becomes very complicated as to who is actually going to do the management of enforcement.

The commonwealth department isn't really geared up to do that, there needs to be some sort of arrangement, probably between state and commonwealth go-, but when you get really a long way offshore, it's a real problem for both levels of government. The only advantage, the further you get off shore, there's probably less, less problems with enforcement unless you're in those areas in the northern parts of Australia where there's going to be a lot of issues associated with people coming across into our sort of international, sorry, into our waters, outside of international waters.

JS: Yeah, yeah that's an ongoing thing. Ok, what's the next question?

OP: Ha! Which real world situation can you give an example? Well, I've probably spoken about the issues with the RSMPA. Well I suppose, it even comes down to fisheries management, we're trying to, in Australia we've been trying to establish ecosystems based fisheries management, and I said that was being a bit of an oxymoron because I think basically to be ecosystem-based management, you've gotta be integrated across all users of the marine environment, it's not just about fisheries.

So if you establish an ecosystem-based fisheries management model, it may not actually take into account the up uses and so that doesn't help if you're trying to establish, trying to manage interaction with the environment, which is what ecosystems based management is all about. It's not about manipulating the environment which some people would like to do, and do. So there is, a problem there also, that we, again, we don't have enough knowledge, although there is quite a bit of work being done by CSIRO now, but I'm not really across, at the moment they're doing a bit of work on ecosystem-based management, but what happened with oceans policy, which said, look we need ecosystem-based management, we need integrated planning, was that in the end governments decided to throw up their hands but we just can't work out what this ecosystem-based management is.

The reason being, they didn't have the science to back it, they didn't have the will to actually do work. And so we've got this situation where everyone knows we've gotta, we've gotta implement this sort of program, and there's other people in other parts of the world trying to do it as well, but we're just not getting efficient scientific knowledge to give us the ammunition to be able to get, or to actually do some pilot projects, we need to do some pilot projects, which are again about building up our marine science knowledge, ok what do we need to know about say about Port Phillip Bay or West Port Bay or the Great Australian Bight or whatever. What do we need to know about the ocean there to be able to do ecosystem-based management, which is basically spatial management.

And oceans policy had that as a core of; at the core of the policy was ecosystem-based integrated regimen planning. We haven't got there yet, but it becomes strategic plans rather than spatial plans. They become pretty much plans for plans, not really genuine outcomes. And again it comes back to, one is science knowledge we don't have, but also there's a real problem with scientists and science being denigrated by other stakeholders. And that another issue as well as, if we had graduate investment, then scientists would have a much stronger position within the whole sort of dynamic of oceans planning, protection and management, but because they'd been well underfunded, because they've had to then sort of engage with industry, in industry projects it starts to sort of create some real problems, like where is the supply of independent scientists?

And even in the case of the north-west shelf in the Kimberley, there's a lot of programs being developed now, and they're sort of sucking in lots of scientists to get involved in government planning processes and so on. You, in the end through, it's very hard to find scientists. And I guess it's also reflective, this whole science-policy gap is that policy by driving a particular outcome, but it also sucks in scientists, and they aren't able to provide really strong, independent public comment.

Australia's got a fairly small pool of marine ecologists, marine scientists, fisheries scientists and so on, and when you lose those to government and to industry, it's very hard then to be able to project strong I suppose community-driven sort of science program. And so groups like AMSA become quite important, but again, a lot of their members are also getting caught up with other processes, and it makes it very hard for them to give really sort of, vigorous robust advice.

JS: Ok, and what was the next question after that?

OP: What main socio-political tensions are behind the science-policy gap? Well I think I've probably alluded to a couple of those I think, but my view, and the view of a lot of others in the environment sector that, and probably across other sectors as well is that scientists are credible messengers. They really, the community does respect what scientists do, and they listen to scientists, I think they get a bit confused at times when there are scientists arguing a different point, especially in the case of climate change, but generally they regard scientists as being those people who can actually give good, rigorous advice. Now, in terms of the socio-political tensions, ah as I said, there has been an attempt by some stakeholders to denigrate the role of science.

Because scientists have been asking the difficult questions, and I think that's what scientists are supposed to be doing. It's supposed to not just gathering data for the sake of gathering data, it's actually to ask the right questions. And sometimes those questions are going to be tough for some stakeholders. And the questions will be tough, and so will the answers to those questions. And so that's ah, I think one of the real problems for science. There's also the issue of where, there is a very small pool of independent scientists to be able to tap into, which I think is also, creates that sort of science-policy gap, that it's very hard to get the right science being done. And to sort of go into areas where perhaps we might, it can, it might be useful, but it doesn't necessarily target the very things we need to know about the environment.

There's obviously also a great deal of debate around what happens with fisheries. Now, fisheries have been going through some tough times in Australia; we've got quite a few of the overfished, most of them are fully fished, and there's a lot of them uncertain, in terms of stock assessments and so on. And so there's a lot of socio-political issues around needing to restructure and adjust fisheries and the fishing industry. Clearly, scientists have a key role to play in terms of, ok, how much fish can we take out of the ocean, and still, and be sustainable? And that's going to be based on science. But it also has an economic outcome. And so obviously, the fishing industry, governments and the community need to work together to ensure that it's sort of a sympathetic reduction of fishing efforts. Now, however, there's also a lot of angst and a lot of concern and uncertainty around that, and that does create tensions between the fishing industry and scientists, and the fishing industry and the community, and that also then plays out about what do we do then about marine protected areas. There's a lot of resistance from fishing industry to marine protected areas. In the case of the oil and gas industry, you've got an industry which is booming.

For very many reasons, particularly the price of oil, etcetera, the need to find transition fuel between coal and renewables, gas is obviously that transitional fuel, so there's an awful lot of pressure on governments, from a tax point of view, they get a lot of money out of it, but also from a economic development point of view, to provide an awful lot of access to the oceans for the oil and gas industry, so when you look at the most recent release of acreage to which has happened just in the last week, virtually all of Western Australian waters and Commonwealth waters of Western Australia are pretty much covered in some form or another by acreage release or leases or whatever.

Now when you, when you get a situation where before you do any planning, you've pretty much allocated the oceans to a particular industry, it creates enormous problems in terms of socio-political tensions which you refer to here, because if you try to find a no take, an area to establish a no take/protected area, where do you do it when every bit of water has actually been allocated to the oil and gas industry, if you regard the oil and gas industry as an extractive industry, which it is, it removes stuff from the sea bed, from under the sea bed, and there's obviously environmental issues in the water column, and in terms of the environment where they actually establish their infrastructure, and so the North-West Shelf's, Scott's Reef, all those sorts of areas, there are some major tensions which are going to develop over the next year or two, because the Kimberley coast, the area off the North-West Shelf has become the focus of everybody's attention. And that's where there's gonna be enormous tensions about how do we actually create an effective network of no-take, or any protected areas, when all the water is pretty much allocated to one industry?

Oh, even, and there's obviously tensions between the fishing industry and the oil and gas industry in terms of just the use of the oceans, and there's clearly tensions between oil and gas, fisheries and the environment sector, and in the case of the Kimberley, Indigenous communities as well. So there's a very potent mix in terms of those socio-political tensions.

And so all those sorts of tensions, I suppose, work around that science tends to get caught up in all of that, so any scientist, any decisions to fund science are going to be very much couched in the way that socio-political tension works out. And in the past, the oil and gas industry and the fishing industry have been able to dominate the outcomes in terms of that tension, and it means that policy and sci-… I guess the gap between science and policy has broadened I guess from our point of view, because we want to have, and I guess it also comes down to what policy we would like. I mean, our policies, whether it's ---- or ---- or ---- or whatever, our policies are usually out there beyond where government wants to be.

And so we would see the gap as even wider than what governments and others might see the science-policy gap as being. So, 'cause the policies that we would like to see in place do require a considerable amount of science to be able to; but there's also the issue I suppose of precaution. And ah, and that's the other issue that; the precautionary principle's unfunded basically, but it does indicate that ok, if you haven't got the science, if you haven't got all the knowledge, you need to be precautionary about your decisions. Unfortunately, that precautionary principle isn't always being followed, in terms of decisions being made around policy. So even though there might be a gap, but in some ways you can bridge that gap by being precautionary.

JS: OK, and is there another question?

OP: Ah yep, there's two more. How do decision-makers fit into the play between science policymakers and the science-policy gap? Ok, well I suppose, uh, well I guess, if we're talking in terms of government decision-makers, rather than decision-makers within industry and so on, ah policymakers are also governments too, to some extent. Ah, pretty much decision-makers are under a great deal of influence, by whoever's got the whip hand of influence. So in terms of oceans, planning, protection and management, it's been largely the oil and gas industry and the fishing industry. And they have very strong support from their respective government departments, whether it's in Commonwealth, where you've got the Industry portfolio or the Fishing portfolio, and in the state governments as well. We, in terms of the environment, we don't have the same champions within the environment departments that the fishing industry and the oil and gas industry have in their departments. The industry department will go out and really sell the idea of oil and gas development.

The fishing department will go out and really sell the idea of fisheries. But the environment departments don't go out and sell protection. And that's, and so the environment departments tend to get caught up in wanting to try and do deals and come to compromises between the, with the others, with the other departments. We saw that in the South East Marine Protected Areas situation. So, when trying to bridge that science-policy gap, again, those departments, the development departments will have much stronger influence over where the money goes in terms of science. It'll have a very strong economic basis to it, to the science.

And ah, that's a real problem as well. Whereas the environment department is usually underfunded, generally. It's all, so it all comes back to the issue about enforcement, even in terms of just resourcing, for instance the provisions of the Environment Protection and Biodiversity Conservation acts, even though we've got all these provisions in there, the resources aren't there to ensure that these things happen.

Recovery plans aren't sort of dealt with, listings aren't done in a timely way, all those sorts of issues come back to resources. Now, the resource departments don't have a problem getting their resources, but the environment departments do. So when you're looking at all that mix, that sort of science-policy gap is going to be accentuated from our point of view because all of any science will go into a fairly narrow area, rather than being much broader in terms of its public benefit.

JS: Ah ok, and the final question?

OP: The final question: What is the dominant culture in marine resource management, and how does this affect the science-policy gap? Well I think I've probably answered that actually in talking about oil and fish, sorry oil and gas, and the fisheries departments and so on.

JS: Ok, well I was going to sort of draw a couple of things in earlier about what you said earlier, about economic interests and science and policy. If you're talking about decision-makers, the people who sort of, 'cause you know, it usually goes up to the ministers or the senior people, and they take advice from different briefs from the policymakers. In terms of decision-making, or the decision-makers themselves, what sort of culture do you think they are more entrenched in, or what sort of world view they have, in terms of dealing in marine protection or marine resource management?

OP: Um, just one second, someone has given me a note, I just have to read that, I'll answer it in a minute. Sorry. In terms of the so basically, the question was where do the decision-makers, what is their world view of? Well unfortunately I suppose, in terms of the oceans, there's still this problem of out of sight, out of mind. There's also a problem that's it's still, oh it's big. And it can withstand a lot of stuff. So, one of the problems we have is that with climate change the oceans are going to be the dominant influence over the impacts of climate change, that is, changes to the oceans will cause changes in rainfall patterns, drought etcetera, because of various currents etcetera and *La Nina*, *El Nino*, and so on. But also oceans will be impacted considerably by climate change. And so there's a double whammy there.

And ah, people still haven't really begun to understand that. I think that's going to be something which decision-makers in terms of marine management, or even coastal management, are really going to have to come to grips with in a very quick period of time.

Now unfortunately, they're pretty much stuck in this more exploitative mode, but they're now couching it in terms of sustainability. But sustainable resource management is different to ecologically sustainable resource use. And I think there's still a problem in trying to get industry and decision-makers to realise that there's more to ecological sustainability than they probably think at the moment.

They think that if they can sustain a fishery, in terms of getting the same catch each year, then that's probably enough, whereas you need to think about whether in fact that catch being taken out each year, ok it may be able to replicate the catch, but is it actually sustainable in terms of the whole ecosystem there? Is it, do we want the ecosystem at that level, because as we've seen in Tasmania, the reserves there, the work that Neville Barrett and Graham Edgar did in the reserves along the East coast showed that fishing in it had actually fished down the natural environment to a far greater level than was first thought.

And in fact, when the fish, when the areas became no take, the natural systems bounced back, well beyond the productivity levels which the scientists expected, which implied that they'd been fished down much further, and so the natural productivity was much higher than people thought. And so, if you're taking out, say for instance, the pre-fished biomass that they think we need to maintain in a fishery is 30%. That means that 70% of the fish have been taken out of the system. Now is that a sustainable thing, in terms of providing biodiversity protection, providing long-term protection for the oceans, when you're actually removing more than half of the biomass. It actually has implications for species which aren't targeted.

JS: Well, the classic example...

OP: It doesn't change the whole, basically ecology of the area, then we have something quite different. So that becomes an issue around what is sustainability. So people have still got the view that, yes we can sustainably fish, we can do this, we can do that, but I think as time goes on, and as climate change kicks in, we're going to have to re-establish what we think it should be happening in terms of managing and protecting the oceans. I think there's a lot of ah, and that comes back to putting some really strong scientific effort into understanding what's possible in the oceans. I think we'll find what's possible is a lot less than what we're doing now.

JS: So, I mean the classic MSY formula is the 50% fish down, but I was just wondering, if in your experience or your knowledge, is, are the decision-makers, are they sort of like an old boys club, in a sense?

OP: I guess there's a mix. There's some who realise what needs to be done, and there's others who perhaps don't necessarily want to realise what has to be done, and they're also very much influenced by the political circumstance of the time. But occasionally you'll get a bureaucrat who sees the need to really make some strong decisions, but I think we need more bureaucrats and others who are prepared to make those tough decisions, or recommend those tough decisions, and for governments to take those tough decisions on. I think we're still some- we're a long way from that yet.

JS: Yeah, because they're very loathe to close a fishery down.

OP: Yeah, well it's not just about closing down, it's really just changing obviously the amount of fish they take out, the type of gear they use, where they do the fishing and so on, but I guess when you look at it, the fishing industry from an economic point of view, obviously it's very important in some regional areas. And it's ah, Australia's fisheries are quite small in value in world standards, and most of the value comes out of, I guess, prawns, rock lobster, abalone and so on. And tuna I guess, and some of the aquaculture sort of projects etcetera. But we're still quite a small fishery in terms, in international terms. And, if you take a patch of something like the Coral Sea, or the Great Barrier Reef, or other parts of the ocean, they're worth far more in terms of tourism, than fisheries. So there's some major, we need to really look at the way, in which what is the best, the most sustainable way of using the oceans, which also have a strong economic and social outcome as well? It may be that fishing is not the way of the future, wild caught fishing.

It doesn't mean to say that fish farming is the way of the future, unless the fish farming is done also in a sustainable way, and unfortunately there have been some bureaucrats in some fisheries agencies who have really gone so gung ho on aquaculture that we've got some real problems in terms of aquaculture.

So it's, I guess another area where ah the policy, their particular policy in regards to aquaculture has outstripped the knowledge that we have about how in fact these areas can actually maintain such uses, and the case is also with desalination; governments are making decisions on where to put desal plants without really thinking about the impacts of those plants.

They made decisions about the plant, the made a decision where to put it, and then they sort of had to retrofit it in terms of environmental effect statements... and so on, which will probably show there's going to be some serious impacts, but they should have thought about it before they actually went around choosing.

JS: Yeah, but also like you said with the tourism stuff, you would have seen up on the Great Barrier Reef the power of the fishing industry because I think they're about 8 or 10% of the income of the reef is fishing and the rest is tourism. Basically you could close down the reef fishing industry and just ah, turn it over to tourism, and it wouldn't be an economic blip, but they've got a very powerful lobby.

OP: Yeah.

-END-

APPENDIX 2

Q. 19 ranked causative factors. 1st = mentioned 1st as a cause, etc.

Government Policy

Factor	Times mentioned 1st	2nd	3rd
Communication problems.	9	1	
Lack of certainty in scientific results.	7	2	
Political interference.	5	3	1
Insufficient science research funding.	4	1	
Lack of understanding by scientists of the policy process.	4		
The kind of advice policymakers need and what science provides.	4		1
Lack of longer term strategic policy.	3		
Cultural differences between science and policy fields.	3	1	
Policymakers not good at asking the right questions of science.	2		
Short-term nature of politics.	2	1	1
Policy has to incorporate economic, social, cultural and scientific considerations.	2	1	
Scientific results used selectively.	2		
Science not good at delivering answers in policy timeframes.	1	4	
Policy failure on decision approach to management.	1		
Not enough field research that is independent from fishing industry support.	1		
Scientific culture of 100% surety before conclusive evidence given.	1		
Greater accountability needed for decision-makers ignoring the science.	1	1	
Lack of commonsense.	1		
Cuts in catch are politically, economically, socially unattractive.	1		
Scientists not generally represented in policy-making bodies.	1		
Lack of understanding the role of science in policy-making by policymakers.	1		
Scientists able to give independent results without fear of political retribution.	1		
Politics of economics – the power of primary industry to lobby government.	1	1	

Government Science

Factor	Times mentioned 1st	2nd	3rd
Political interference.	17	2	2
Communication problems.	8		
Politics of economics – the power of primary industry to lobby government.	4		
Cultural differences between science and policy fields.	3		
Science not good at delivering answers in policy timeframes.	3	1	
Scientific results used selectively.	3	1	
Conflict between long-term sustainability and short-term economic needs.	2		
Lack of science education in policy.	2	1	
Lack of certainty in scientific results.	2		
Short-term nature of politics.	1		
Scientists able to give independent results without fear of political retribution.	1	1	
Insufficient science research funding.	1		
Policy failure on decision approach to management.	1		
The kind of advice policymakers need and what science provides.	1	1	
Lack of quantitative data (notably in fisheries).	1		
Lack of understanding the role of science in policy-making by policymakers.	1		
Policy has to incorporate economic, social, cultural and scientific considerations.	1		
Lack of longer term strategic policy.		1	
Policymakers not good at asking the right questions.		1	

Academic

Factor	Times mentioned 1st	2nd	3rd
Political interference.	11	1	
Cultural differences between science and policy fields.	8		
Communication problems.	6	2	
Conflict between long-term sustainability and short-term economic needs.	5	1	
Lack of certainty in scientific results.	4	2	
Short-term nature of politics.	4	1	
Insufficient science research funding.	4		
Lack of science education in policy.	4		
Scientific results used selectively.	2		
Lack of longer term strategic policy.	1		
Policy failure on decision approach to management.	1		
Lack of quantitative data (notably in fisheries).	1		
Unwillingness of scientists to promote a particular policy solution.	1		
Lack of understanding by scientists of the policy process.	1		
Policy has to incorporate economic, social, cultural and scientific considerations.	1		
Lack of understanding the role of science in policy-making by policymakers.		1	
Policymakers not good at asking the right questions.		1	
The kind of advice policymakers need and what science provides.			1

Industry group

Factor	Times mentioned 1st	2nd	3rd
Political interference.	6		
Communication problems.	2	1	
Lack of certainty in scientific results.	1		
Not enough field research that is independent from fishing industry support.	1		
Scientific culture of 100% surety before conclusive evidence given.	1		
The inability of science and policy to listen to grassroots industry.	1		
Policy failure on decision approach to management.		1	
Policymakers not good at asking the right questions.		1	
Lack of understanding the role of science in policy-making by policymakers.			1

Environment group

Factor	Times mentioned 1st	2nd	3rd
Political interference.	6		
Politics of economics – the power of primary industry to lobby government.	2	1	
Unwillingness to accept the Precautionary Principle.	2	1	
Conflict between long-term sustainability and short-term economic needs.	1		
Policy has to incorporate economic, social, cultural and scientific considerations.	1		
Short-term nature of politics.		1	
Scientists able to give independent results without fear of political retribution.		1	

APPENDIX 3

Q. 20 ranked solution factors. 1^{st} = mentioned 1^{st} as a solution, etc.

Government policy

Factor	Times mentioned		
	1^{st}	2^{nd}	3^{rd}
Better communication between science and policymakers.	14		
Greater interaction and integration between scientists and policymakers.	9	2	
More scientific research with a focus on policy context and policy needs.	5	1	
Embed researchers in policy and *vice versa* for real world experience.	4		
Policymakers asking clearer questions.	3		
Align long-term research and policy strategies.	3	3	
Scientists being prepared to engage in public debate on contentious issues.	2		
Policy can better accommodate uncertainty.	2		
Integrate more fully the science requirements in policy management.	2	4	
Policy needs to have longer term vision and resist short-term politics.	1		
A greater understanding by scientists of policy process and requirements.	1	3	
Make decision-makers more accountable.	1	2	
Scientific funding independent and less reliant on industry support.	1		
Measurable environmental objectives.	1		
Get more scientists into policy-making bodies.	1		
Change timeframes so that policy people stay longer in a role.	1		
Involve all stakeholders in decision making.	1		
Be clear about what questions science can answer and what it cannot.	1		
More openness and transparency in the processes.		1	1
Minimize political/vested interest interference with science/policy process.			1

Government science

Factor	Times mentioned		
	1^{st}	2^{nd}	3^{rd}
Better communication between science and policymakers.	13	1	
Align long-term research and policy strategies.	4		
Recruit professional resource managers instead of career public servants.	4		
Good independent science should be the basis of policy.	4		1
Embed researchers in policy and *vice versa* for real world experience.	3		
Encourage policy areas to engage staff with scientific credentials.	3		
A greater understanding of science by policymakers.	3	1	1
Make decision-makers more accountable.	2		
Scientific funding independent and less reliant on industry support.	2	1	
More independence of policymakers from Govt to stop the use of selective science.	2		
A greater understanding by scientists of policy process and requirements.	1	1	
Policymakers asking clearer questions.	1		1
Policy can better accommodate uncertainty.	1		
Minimize political/vested interest interference with science/policy process.	1	2	
Recognize that science advises; it does not set objectives.	1		
Involve all stakeholders in decision making.	1		
Greater interaction and integration between scientists and policymakers.		2	
More scientific research with a focus on policy context and policy needs.		1	
Change timeframes so that policy people stay longer in a role.		1	

Academic

Factor	Times mentioned		
	1st	2nd	3rd
Better communication between science and policymakers.	9	2	
Good independent science should be the basis of policy.	6		
Greater interaction and integration between scientists and policymakers.	4		1
A greater understanding by scientists of policy process and requirements.	4		
Embed researchers in policy and *vice versa* for real world experience.	3	2	
Get more scientists into policy-making bodies.	3		
More scientific research with a focus on policy context and policy needs.	2	1	
Policy needs to have longer term vision and resist short-term politics.	2	2	
Policy can better accommodate uncertainty.	2		
A greater understanding of science by policymakers.	2	4	
More openness and transparency in the processes.	2		
Integrate more fully the science requirements in policy management.	2		
Minimize political/vested interest interference with science/policy process.	1	1	
Recruit professional resource managers instead of career public servants.	1		
Involve all stakeholders in decision making.	1		
Greater attention to the UN as a source of neutral science and policy.	1		
More scientifically trained politicians.	1		
More independence of policymakers from Govt to stop the use of selective science.	1		
Remove political and industry representation on research boards.	1		

Industry group

Factor	Times mentioned		
	1st	2nd	3rd
Keep scientific advice independent from the influence of policymakers.	3		
Greater interaction and integration between scientists and policymakers.	1		
Policymakers asking clearer questions.	1		
Scientific funding independent and less reliant on industry support.	1		
More scientifically trained politicians.	1		
Agreed environment parameters so that economic value and the environment are protected.	1		
More scientific research with a focus on policy context and policy needs.		2	

Environment group

Factor	Times mentioned		
	1st	2nd	3rd
Good independent science should be the basis of policy.	4		
Better communication between science and policymakers.	2		
Keep scientific advice independent from the influence of policymakers.	1		
More funding for broader, longer-term, ecosystem/biodiversity research.	1	1	
Remove political and industry representation on research boards.	1		
Be clear about what questions science can answer and what it cannot.	1		

APPENDIX 4

Q. 19 causative factors ranked by frequency of appearance and type.

Government Policy

Factor	Rank	Type
Communication problems.	1	Dialogue
Lack of certainty in scientific results.	2	Understanding
Political interference.	3	Interference
Insufficient science research funding.	4	Independence
Lack of understanding by scientists of the policy process.	4	Understanding
The kind of advice policy-makers need and what science provides.	4	Understanding
Lack of longer term strategic policy.	5	Policy failure
Cultural differences between science and policy fields.	5	Understanding
Policy-makers not good at asking the right questions of science.	6	Understanding
Short-term nature of politics.	6	Interference
Policy has to incorporate economic, social, cultural and scientific considerations.	6	Understanding
Scientific results used selectively.	6	Interference
Science not good at delivering answers in policy timeframes.	7	Understanding
Policy failure on decision approach to management.	7	Policy failure
Not enough field research that is independent from fishing industry support...	7	Independence
Scientific culture of 100% surety before conclusive evidence given.	7	Understanding
Greater accountability needed for decision-makers ignoring the science.	7	Interference
Lack of commonsense.	7	Understanding
Cuts in catch are politically, economically, socially unattractive.	7	Interference
Scientists not generally represented in policy-making bodies.	7	Understanding
Lack of understanding the role of science in policy-making by policy-makers.	7	Understanding
Scientists able to give independent results without fear of political retribution.	7	Interference
Politics of economics – the power of primary industry to lobby government.	7	Interference

Government Science

Factor	Rank	Type
Political interference.	1	Interference
Communication problems.	2	Dialogue
Politics of economics – the power of primary industry to lobby government.	3	Interference
Cultural differences between science and policy fields.	4	Understanding
Science not good at delivering answers in policy timeframes.	4	Understanding
Scientific results used selectively.	4	Interference
Conflict between long-term sustainability and short-term economic needs.	5	Interference
Lack of science education in policy.	5	Understanding
Lack of certainty in scientific results.	5	Understanding
Short-term nature of politics.	6	Interference
Scientists able to give independent results without fear of political retribution.	6	Interference
Insufficient science research funding.	6	Independence
Policy failure on decision approach to management.	6	Policy failure
The kind of advice policy-makers need and what science provides.	6	Understanding
Lack of quantitative data (notably in fisheries).	6	Research lacking
Lack of understanding the role of science in policy-making by policy-makers.	6	Understanding
Policy has to incorporate economic, social, cultural and scientific considerations.	6	Understanding

Academic

Factor	Rank	Type
Political interference.	1	Interference
Cultural differences between science and policy fields.	2	Understanding
Communication problems.	3	Dialogue
Conflict between long-term sustainability and short-term economic needs.	4	Interference
Lack of certainty in scientific results.	5	Understanding
Short-term nature of politics.	5	Interference
Insufficient science research funding.	5	Independence
Lack of science education in policy.	5	Understanding
Scientific results used selectively.	6	Interference
Lack of longer term strategic policy.	7	Policy failure
Policy failure on decision approach to management.	7	Policy failure
Lack of quantitative data (notably in fisheries).	7	Research lacking
Unwillingness of scientists to promote a particular policy solution.	7	Independence
Lack of understanding by scientists of the policy process.	7	Understanding
Policy has to incorporate economic, social, cultural and scientific considerations.	7	Understanding

Industry group

Factor	Rank	Type
Political interference.	1	Interference
Communication problems.	2	Dialogue
Lack of certainty in scientific results.	3	Understanding
Not enough field research that is independent from fishing industry support.	3	Independence
Scientific culture of 100% surety before conclusive evidence given.	3	Understanding
The inability of science and policy to listen to grassroots industry.	3	Understanding

Environment group

Factor	Rank	Type
Political interference.	1	Interference
Unwillingness to accept the Precautionary Principle.	2	Understanding
Politics of economics – the power of primary industry to lobby government.	2	Interference
Conflict between long-term sustainability and short-term economic needs.	3	Interference
Policy has to incorporate economic, social, cultural and scientific considerations.	3	Understanding

APPENDIX 5

Q. 20 solution factors ranked by frequency of appearance and type.

Government policy

Factor	Rank	Type
Better communication between science and policymakers.	1	Dialogue
Greater interaction and integration between scientists and policymakers.	2	Integration
More scientific research with a focus on policy context and policy needs.	3	Integration
Embed researchers in policy and *vice versa* for real world experience.	4	Understanding
Policymakers asking clearer questions.	5	Understanding
Align long-term research and policy strategies.	5	Integration
Scientists being prepared to engage in public debate on contentious issues.	6	Engagement
Policy can better accommodate uncertainty.	6	Understanding
Integrate more fully the science requirements in policy management.	6	Integration
Policy needs to have longer term vision and resist short-term politics.	7	Interference
A greater understanding by scientists of policy process and requirements.	7	Understanding
Make decision-makers more accountable.	7	Engagement
Scientific funding independent and less reliant on industry support.	7	Independence
Measurable environmental objectives.	7	Independence
Get more scientists into policy-making bodies.	7	Integration
Change timeframes so that policy people stay longer in a role.	7	Engagement
Involve all stakeholders in decision making.	7	Engagement
Be clear about what questions science can answer and what it cannot.	7	Understanding

Government science

Factor	Rank	Type
Better communication between science and policymakers.	1	Dialogue
Align long-term research and policy strategies.	2	Integration
Recruit professional resource managers instead of career public servants.	2	Engagement
Good independent science should be the basis of policy.	2	Science leads policy
Embed researchers in policy and *vice versa* for real world experience.	3	Understanding
Encourage policy areas to engage staff with scientific credentials.	3	Integration
A greater understanding of science by policymakers.	3	Understanding
Make decision-makers more accountable.	4	Engagement
Scientific funding independent and less reliant on industry support.	4	Independence
More independence of policymakers from Govt to stop the use of selective science.	4	Interference
A greater understanding by scientists of policy process and requirements.	5	Understanding
Policymakers asking clearer questions.	5	Understanding
Policy can better accommodate uncertainty.	5	Understanding
Minimize political/vested interest interference with science/policy process.	5	Interference
Recognize that science advises; it does not set objectives.	5	Understanding
Involve all stakeholders in decision making.	5	Integration

Academic

Factor	Rank	Type
Better communication between science and policymakers.	1	Dialogue
Good independent science should be the basis of policy.	2	Science leads policy
Greater interaction and integration between scientists and policymakers.	3	Integration
A greater understanding by scientists of policy process and requirements.	3	Understanding
Embed researchers in policy and *vice versa* for real world experience.	4	Understanding
Get more scientists into policy-making bodies.	4	Integration
More scientific research with a focus on policy context and policy needs.	5	Integration
Policy needs to have longer term vision and resist short-term politics.	5	Interference
Policy can better accommodate uncertainty.	5	Understanding
A greater understanding of science by policymakers.	5	Understanding
More openness and transparency in the processes.	5	Understanding
Integrate more fully the science requirements in policy management.	5	Integration
Minimize political/vested interest interference with science/policy process.	6	Interference
Recruit professional resource managers instead of career public servants.	6	Engagement
Involve all stakeholders in decision making.	6	Engagement
Greater attention to the UN as a source of neutral science and policy.	6	Independence
More scientifically trained politicians.	6	Understanding
More independence of policymakers from Govt to stop the use of selective science.	6	Interference
Remove political and industry representation on research boards.	6	Interference

Industry group

Factor	Rank	Type
Keep scientific advice independent from the influence of policymakers.	1	Interference
Greater interaction and integration between scientists and policymakers.	2	Integration
Policymakers asking clearer questions.	2	Understanding
Scientific funding independent and less reliant on industry support.	2	Independence
More scientifically trained politicians.	2	Understanding
Agreed environment parameters so that economic value and the environment are protected.	2	Independence

Environment group

Factor	Rank	Type
Good independent science should be the basis of policy.	1	Science leads policy
Better communication between science and policymakers.	2	Dialogue
Keep scientific advice independent from the influence of policymakers.	3	Interference
More funding for broader, longer-term, ecosystem/biodiversity research.	3	Independence
Remove political and industry representation on research boards.	3	Interference
Be clear about what questions science can answer and what it cannot.	3	Understanding

APPENDIX 6

Q. 19 verbatim answers and coding for the question:
'For you, what is the single most important factor causing the science-policy gap?'

Note: This is a *verbatim* transcription of the written answers given by the respondents.
It has been carefully vetted and any errors of grammar or spelling are those of the survey respondents.
The use of capitals, underlining, arrows, quotation marks &Co., are what the respondents used to emphasize their thoughts.

Q. 19 Factor Key

A - Communication problems.
B - Science not good at delivering answers in policy timeframes.
C – Lack of certainty in scientific results.
D - Political interference.
E - Insufficient science research funding.
F – Lack of understanding by scientists of the policy process.
G - Lack of longer term strategic policy.
H - Policy failure on decision approach to management.
I - Not enough field research that is independent from fishing industry support.
J - Scientific culture of 100% surety before conclusive evidence given.
K - Cultural differences between science and policy fields.
L - Policymakers not good at asking the right questions of science.
M - Greater accountability needed for decision-makers ignoring the science.
N - Lack of commonsense.
O - Cuts in catch are politically, economically, socially unattractive.
P - Scientists not generally represented in policy-making bodies.
Q - Lack of understanding the role of science in policy-making by policymakers.
R - Short-term nature of politics.
S - Policy has to incorporate economic, social, cultural and scientific considerations.
T - The kind of advice policymakers need and what science provides.
U - Scientific results used selectively.
V - Scientists able to give independent results without fear of political retribution.
W - Politics of economics – the power of primary industry to lobby government.
X - Conflict between long-term sustainability and short-term economic needs.
Y – Lack of science education in policy.
Z – Lack of quantitative data (notably in fisheries).
α - Unwillingness of scientists to promote a particular policy solution.
β - The inability of science and policy to listen to grassroots industry.
γ - Unwillingness to accept the Precautionary Principle.
----- Indeterminate answer, not used.

Sector	The single most important factor causing the science-policy gap	Factor	Respondent
Govt policy	A failure to come to an agreement on an appropriate approach to policy decision making regarding natural resources management.	H	19
Govt policy	An absence of accountability for decision makers largely as a result of short term political cycles and job tenure for public servants. Scientific uncertainty gives these 'managers' a very convenient opportunity to delay important/consequential decisions. As good as it is in theory the Precautionary Principle is often ignored in practise.	M, C	20
Govt policy	Communication problems being the most important factor! As a policy/manager who used to be a scientist I believe that most scientists want to provide valued research to assist in better management and policy outcomes. Scientists should however stick to advising what the resource or environment should contain or look like and leave the policy officer/managers to use/implement the appropriate tools to achieve the optimal endpoint that the scientist may be recommending or modelling.	A	21
Govt policy	The lack of proper communication and understanding of factors which are causing uncertainty. Lack of politicians ability to comprehensively understand uncertainty. Industry exploiting uncertainty with politicians.	A, C, D	22
Govt policy	Marine science is now largely desk based and too reliant on modelling. There is not enough on the water and fishery independent research being carried out largely due to cost.	I, E	26
Govt policy	The scientific culture of always needing to 100% sure before providing conclusive evidence.	J	28
Govt policy	Insufficient 2way communication between researchers and decision makers, especially in terms of knowing each others language-sets and what is and un/important to each communities understanding of good natural resource management.	A, K	29
Govt policy	Policy makers are not good at asking the right questions and scientific process is not good at delivering answers in the time frame required by policy makers.	L, B	30
Govt policy	Lack of communication between scientists and managers – this is a 2way street.	A	31
Govt policy	Political expediency.	D	34

Govt policy	Time and funding constraints. To adequately inform policy, science needs to occur before there is a problem. However to do this, science needs to be "crystal ball gazing" to know what will be an issue. This requires a bit of time and resources to allow science to be undertaken without a defined need. The current funding process allows science to only focus on current problems – but given time needed to do a scientific program policy is made without the scientific input.	E, B	35
Govt policy	Science not providing recommended scientific options for policy makers to use in using the information	T	36
Govt policy	Policy makers (frequently under the direction of politicians) ignore scientific advice because of uncertainty or because it is too difficult to do anything about it. Greater accountability is required for ignoring scientific advice.	V, M	37
Govt policy	Reduce uncertainty in fisheries stock management	C	38
Govt policy	Effective communication – particularly relating to what science is saying. Also science often takes too long – i.e. needs to be more strategic in "forecasting" policy needs.	A, B	39
Govt policy	Lack of commonsense, listening to reason of non-scientific yet extremely valid observations of the wider community.	N	40
Govt policy	Lack of longer term strategic policy, within which short term decisions (and research), are needing to fit.	G	41
Govt policy	Independent funding of research and or availability of data to undertake the research to answer the question. Classic is little or no investment in Biodiversity based Science in Australia and benchmarking.	E	42
Govt policy	Lack of certainty in scientific outcomes. This leaves an easy "out" for any policy maker that might be influenced by other more "certain" factors i.e. economic, political factors.	C, D	43
Govt policy	Lack of research funding in small or developing fisheries and in marine ecosystem health.	E	45
Govt policy	Lack of social and economic science information to be delivered in conjunct with biological info.	-----	46

Govt policy	That somewhere between the two is the inexact science of economics. Science tends to be black and white, experiments can be controlled, actual data can be collected. Economics relies upon observed data, so there are no results until observed. However in Fisheries the problem is, who is the observer and why are they observing. With so many eyes, different people see different things from the data. Until, or even if, economics becomes more precise then science will fall by the wayside because of then the economics can't back up the science.	-----	48
Govt policy	Lack of scientific evidence of known sensitivity, robustness and uncertainty, leading to lack of defensibility and often over-interpretation of results.	C	49
Govt policy	-Lack of understanding by scientists of the policy process -Lack of incentives for scientists to contribute to policy through their work -Policy processes being too tightly driven by political processes and short time horizons -Few scientists who appreciate 'system' thinking / lack of cross-disciplinary dialogue.	F, D, R	51
Govt policy	Uncertainty in research combined with no measurable objectives for what people want for the environment, combination of these means that everything is negotiable	C, D	53
Govt policy	There is no <u>one</u> single factor	-----	54
Govt policy	Bad news is hard to accept. Most indicators are trending downward; ↓biodiversity, ↓biomass, ↑pollution. If scientists show an improvement it easy to accept. Follow-up actions, e.g. cuts in catch are politically, economically and socially unattractive.	O	57
Govt policy	Scientists are generally not represented in policy making bodies. Often the best scientific advice is taken to be what the newspaper says.	P	59
Govt policy	Uncertainty in accuracy of data usually resulting from data sets that are not continuous or are broken.	C	60
Govt policy	Political interference in response to a potential negative effect of a decision on some segment of the population.	D	65
Govt policy	The lack of targeted science and lack of communication between scientists and policy makers on the needs of both.	A	66
Govt policy	Lack of understanding by scientists of the political processes involved in policy making.	F	69

Govt policy	Lack of good communication between research officers and policy officers.	A	70
Govt policy	Understanding the role of science.	Q	73
Govt policy	Communication: Asking the right management questions prior to embarking on research to find the answers. Communicating results back to policy makers in a way that they can understand. Short term nature of politics: Questions can not always be fully explored and answered scientifically to satisfy policy makers.	A, R, T	74
Govt policy	Different timeframes – long term strategic research versus shorter term policy decision making plus frequent changes in policy direction.	G	75
Govt policy	Asking the right questions over the right timeframe.	L, B	76
Govt policy	The difficulties in translating scientific knowledge into places/times remote from its production in a meaningful way.	T	78
Govt policy	Political influence in a democracy.	D	82
Govt policy	The biggest issue for science and policy is the tendency for science to come up with either multiple answers or answers at the extreme end of the spectrum of options. This provides no guidance to policy makers. The science needs to provide an analysis of options and the consequences of choosing each option. The lack of accountability of scientists is also a significant contributor to the gap.	T	86
Govt policy	Funding to allow science to go to the depth/detail required/desired by policy makers.	E	87
Govt policy	The gap is just as much about the gap between the Kind of advice policy makers need and what scientists deliver. In other words scientists are often not interested in the questions policy makers have. I think the gap is largely a construct of people who have an oversimplified view of policy making. Policy has to incorporate economic, social, cultural and scientific considerations. Science is very important, but not the only consideration.	T, S	89
Govt policy	If there is one, it is probably caused in some areas by a level of confidence on the part of some governments that their policy is solid and has public support: so the science/scientific results are only used to bolster the existing policy.	V	90
Govt policy	Lack of communication.	A	95

Govt policy	Time – political decisions often need to happen much faster than scientific research can provide 'answers'. Politics of economics – the power of the primary industry to lobby government.	B, W	98
Govt policy	Scientists not understanding the type and timing of information required for policy formulation.	F	99
Govt policy	Culture – the lack of communication of different processes, needs and outcomes by scientists AND policy makers with each other. Both are primary in their view and either takes time to explain to each other why and how.	K	101
Govt policy	Ineffective communication	A	102
Govt policy	Lack of high quality, resourced policy process that e.g. provides the time and resources to develop good policy, based on good advice/research.	G	106
Govt policy	Politics – policy decisions are made based on many factors, only one of which is science.	D	109
Govt policy	Understanding on both sides of the different timeframes that each work in.	K	110
Govt policy	Science generally answers small problems in long time frames. Management generally needs answers to large scale problems. Research conducted doesn't generally consider all elements – no advice for realistic management and no consideration (not practical or real world) of social or economic issues. Although personally would like more stringent environmental protection through policy and management one must take off the rose coloured glasses and try to work within the political, social and economic framework that exists. Research questions that try to influence management must recognise this.	S	111
Govt policy	Lack of understanding from science on the policy process and where all science disciplines (social, economic and physical/biological/ecological) fit in.	F	113
Govt policy	The fear of science provides that giving their "best" advice (based on evidence gained by their research) might mean that they alienate their funding sources.	V	115
Govt policy	I see science as one input → policy includes science and values.	S	116
Govt policy	Uncertainty in science, upon which policy decisions need to be made.	C	120
Govt policy	Politicians	D	130

Govt policy	Cultural factors, which include communication.	K	146
Govt policy	Short term research for short term policy.	R	156
Govt policy	Policy tends to be based on short time-frames, such as the period between elections or the brief time (18 months – 3 years) that an ambitious policy person remains in one position focussed on a particular issue. Scientists tend to become entrenched in a topic and they may not see the bigger picture. The performance system for scientists (count the papers) does not encourage well-targeted policy driven/relevant research.	R	167
Govt policy	Inability of science to be 100% sure ie uncertainty when policy usually assumes certainty.	C	177
Govt policy	Short-term politically motivated policy decision making at the expense of better triple bottom line outcomes for the future!	D	208
Govt science	Political interests.	D	24
Govt science	Different time-frames for decisions (days or weeks) vs research and assessment.	B	27
Govt science	Inadequate levels of funding to conduct research at the scales fisheries exist at. Both spatially and temporally.	E	33
Govt science	Cultural barriers.	K	63
Govt science	Cultural/epistemological differences → Incapacity and low enthusiasm for "reframing" interpretations of an issue.	K	93
Govt science	Vested interest by corporations.	D	97
Govt science	People having hidden agendas.	D	123
Govt science	Political decisions motivated by Politicians personal financial gain or to "save face" after Pre election statements.	D	124
Govt science	Science is not answering the policy questions asked	T	131
Govt science	Disagreement of what action to take between industry members of an industry. This results in political action by the disenchanted faction.	W	132
Govt science	Uncertainty	C	136
Govt science	Political will	D	139
Govt science	Short-termism	R	140

Govt science	Policy makers chose the short term interests of an industry over the long term interests of the ecosystem (and that industry) because they are ignorant and gutless, and because the environment doesnt vote.	D	141
Govt science	The use of scientific results to justify a political decision, when there is no avenue for the scientists to rebutt the argument without losing their job.	U, V	142
Govt science	Preference for short-term gains for the few over long-term sustainability for the many – in short, GREED.	X	144
Govt science	Political influence	D	147
Govt science	Lack of quantitative data (notably in fisheries).	Z	148
Govt science	Inadequate communication.	A	149
Govt science	The conflict between long-term sustainability goals and economic needs of fishers.	X	151
Govt science	Policy makers can either choose to accept or ignore the scientific advice at their whim.	U	154
Govt science	Unrealistic expectations/misunderstandings between scientists and managers.	A	159
Govt science	Lack of education (managers). Analogy is "Build a rocket and then let a child fly it to the moon".	Y	160
Govt science	Clear policy objectives	H	168
Govt science	- Lack of communication between researchers and policy makers - Policy makers lack of ability to state their information needs and rationale for specific policy needs	A, T	169
Govt science	Short term nature of political process and decision making. No long term vision 20-50 years rather 3-4 vision aligned to political angle. Hence no commitment to long term research programs rather reactive research.	D, G	175
Govt science	Poor understanding between the two groups about how the other operates, and what the most influential factors in decisions are.	K	178
Govt science	Political marginalisation of science and scientists	D	183
Govt science	Policy requiring scientific advice in too short time frame to adequately research the issue.	B	184

Govt science	Politicians agendas	D	185
Govt science	The vested interest in economics of management policy. This is a central reason for the collapse of fisheries the world over. In this example management is driven by economics rather than biology of the species involved with the result of overfishing that we see in virtually of the world's major fisheries today.	D	186
Govt science	The lack of common language and way of looking at things to understand that it is all one spectrum and that we all have a role to play in policy development.	A	187
Govt science	Inadequately trained people involved in policy development. Political sycophants driving the agenda.	Y, D	188
Govt science	Commercial industry and political factors often weighed up against the scientific advice.	D	192
Govt science	Pressure from commercial enterprises.	W	201
Govt science	Pressure from commercial interests	W	203
Govt science	Dealing with scientific uncertainty	C	204
Govt science	Policy makers with little knowledge of science marginalising scientific inputs.	D	205
Govt science	Economic and political ramifications.	W, D	206
Govt science	Lack of dialogue/communication between policy makers and scientists. Policy makers do not generally ask for answers to areas for which they require information.	A, L	209
Govt science	Lack of understanding of scientific process by policy makers.	Q	210
Govt science	Lobby groups with self serving agendas that have no scientific foundation.	D	211
Govt science	Science need to be adequately supported with scientists able to provide independent advice without fear of political retribution if the answers are not what was required for political or economic purposes. Perceived disconnection between science and policy will not be solved by having more managers and political interference. All too often this is the result of uncertainty in the policy-science relationship. It just increases workloads for scientists and gives them less time for delivering useful results. At the same time more management typically means less resource for science and more political interference.	V, B, D	212

Govt science	I don't have much to do with "creating policy", but from my perspective there is a gap in the way scientific results are communicated. In general, people have short memories, they dislike uncertainty and they do not understand scientific principles of research.	A	214
Govt science	Distrust.	-----	215
Govt science	Economic rationalisation	D	217
Govt science	A lack of 'science of policying'.	-----	219
Govt science	Poor communication, especially poor understanding of scientific language (e.g. uncertainty) by policy makers.	A, Y	220
Govt science	Science and Policy are 2 separate worlds. - Language - Time-frame - Motivation It's difficult to communicate across that cultural divide – not impossible.	A	221
Govt science	Policy makers usually have their own agenda, and will therefore pick and choose what science to base their policy on.	U	222
Govt science	Science is not the only relevant factor.	S	223
Govt science	Economic consequences	D	226
Govt science	In my opinion, the time frame for policy decisions is usually to short. As a result, science that is fundamental to the questions is not funded adequately or given sufficient time to answer the key questions. Policy makers either ignore the inadequacy of the science, or make policy based upon flawed research results. Another significant influence is political/commercial meddling.	B, U, D	230
Govt science	Greed, religion, economics.	D	232
Enviro group	Unwillingness to accept the precautionary principle	γ	47
Enviro group	Political and industry pressure on scientific research. Political and industry gagging of researchers and independent ecological research.	D, V	71
Enviro group	Science is not the sole criterion for policy development.	S	79
Enviro group	Undue influence of commercial vested interests in exploiting inevitable uncertainty inherent in scientific advice based on inevitably incomplete information.	W	81
Enviro group	Short-term political agendas.	D	91

Enviro group	Commercial and Industry interests determines politics and policy in this day under current Government. Also, commercial/industry interests are preventing scientists from having a voice.	W	100
Enviro group	Uncourageous and often embattled policy makers.	D	103
Enviro group	Political influences – by which I mean the combined effect of economic and geopolitical interests at state/relevant authority level.	D	104
Enviro group	Politics and Corporations	D, W	105
Enviro group	Lack of management/policy-making frameworks and scientific advice that clearly incorporates risk assessments and the precautionary approach.	γ	107
Enviro group	Politics	D	112
Enviro group	Political influences: no political will to enact good policy – election cycle.	D, R	114
Enviro group	The prioritisation of economic/industry concerns over scientific precautionary ecological knowledge and the unwillingness of government to use independent science as a basis/guide for their decisions.	X, γ	121
Industry group	Again varies according to the management landscape. Where Science is truly seen as being "science" in the broadest sense and takes a multi-disciplinary approach and the lines of communication between scientists, policy-makers and other stakeholders are clear and transparent then the science-policy gap is likely to be closed. Where scientific and policy-making institutions are seperated and insular, where lack of communication exists the gap remains. In addition, where the decision-making process is poorly defined and not transparent and the exact role of science is poorly enunciated the gap will remain.	A, H, Q	2
Industry group	Hidden agendas! I think there are to many people that have chips on there shoulder, while the politicians change regular the scientists and policy makers seem to be there forever (then the begin forming opinions)	D	3
Industry group	Data collection by scientists from log-books, i.e. fisherman information which can be flawed yet is used to determine F_{msy} of a species or scientific "precautionary principle" advice about yearly renewable species subject to major weather, tidal influences!	I	4

Industry group	Political imperative. Note the number of decisions made just prior to any election. The policy decisions made at the time are invariably what is perceived to be popular to the electorate and rarely has 'scientific validity'. Often it is a 'trade-off' with a special interest group to obtain electoral support or a 'trade-off' for a previously unpopular decision. Witness decisions to favour perceived recreational fishing interests.	D	5
Industry group	The inability of Science and Policy (Politics) to understand and listen to the Grass Roots of Industry	β	6
Industry group	Don't see one	-----	7
Industry group	Bias of scientists towards a pre-determined outcome	D	8
Industry group	1. Scientists are unwilling to get off the fence, i.e. conditional response. 2. Poorly framed questions.	J, L	9
Industry group	At Commonwealth level, it is first uncertainty, second inability in some cases for both sides – scientists/industry to communicate. Having an interface – BRS – helps. At State level, inability to communicate the science.	C, A	10
Industry group	Communication between groups	A	12
Industry group	Politics	D	15
Industry group	Beaurocratic agenda	D	16
Industry group	The lack of independent, objective science and its communication to policy makers…	D	17
Academic	Political factors- often driven economic factors.	D	18
Academic	Lack of willingness for Govt and policy developers to engage Aboriginal and TS Islanders on marine ecosystems management projects.	-----	23
Academic	Political agendas	D	25
Academic	Lack of scientific expert certainty. Scientific disagreement. Short term political considerations being prioritised. National self-interest as opposed to global perspectives being prioritised. Cost of policy (economic).	C, R	50
Academic	Time frames of good science and political imperatives of next election.	R	55
Academic	Lack of scientific knowledge.	Z	56

Academic	-Reduction in research funding for 'pure' research, meaning more is available for targeted research. -Communication of scientific results to policy-makers.	E, A	58
Academic	Lack of certainty. For example, how can a clear decision be made if the results are not certain? Greenpeace scientists argue that the current rate of fishing for Southern Bluefin Tuna will mean the extinction of the species in 2020. CSIRO scientists dispute this. Therefore, policy decisions on SBT are based on economical reasons, rather than pure scientific results.	C	61
Academic	Different cultures: Linear, reductionist, limited scale vs multiple/time scales. Multi-objectiv.	K	67
Academic	Lack of knowledge of science and distrust of scientists by politicians, the media and many community leaders.	Y	68
Academic	There are other factors that must be taken into account by policy makers.	S	77
Academic	Political commitment to growth, against sustainability, in an environment of short-term outcomes.	Y	80
Academic	Lack of political will to acknowledge and address problems.	D	83
Academic	Probably the lack of understanding of the policy process on the part of scientists (including many Soc Sci and humanities disciplines as well as the vast bulk of natural scientists). This is probably more significant than the converse poor understanding of different disciplines by policy agencies and actors.		84
Academic	Different operating paradigms and different processes and degrees of certainty	K	85
Academic	The blatant political manipulation of science and policy to further economic and institutional factors	D	92
Academic	The need for expensive investigation and possible remediation as a result of very research (chemical contamination of estuaries).	-----	94
Academic	The cultural/understanding gap between scientists and policy professionals. They work in different ways, are trained differently and hence <u>do not</u> (in general) <u>understand where the other person is coming from.</u> Both are "absolutists".	K	96
Academic	Uncertainty	C	118
Academic	Democracy is biased towards very short term objectives. The current process based on 3-4 yearly elections.	R	119

Academic	The inability of scientists to understand the way that they think! They are trained in a way that is diagnostic and is poor at finding solutions, do not understand adding value, and do not create. Thinking and world views is the core of the problem.	-----	122
Academic	Short-term decision making driven by political (and economic) imperatives in a long-term issue environment.	Y	127
Academic	Not fitting current government goals	D	128
Academic	Human nature, vested interest.	D	133
Academic	Economic imperatives and differences in time scales of dynamics of ecological and economic systems	Y	135
Academic	Time-frame (short-term vs long-term) (and Courage)	R	138
Academic	Lack of Political will. Scientists cannot give 100% certain answers.	D, C	150
Academic	Formulating policy for short term political and economic gains.	Y	152
Academic	Lack of understanding.	A	153
Academic	Different goals: Science: investigating biology, social structures… Policy: balancing nature, politics, economics…	K	155
Academic	Funding – allows greater volume of appropriate research.	E	157
Academic	Policy makers not accepting the science and bowing to political pressure from groups with an economic interest.	D	158
Academic	The lack of available funding to address the critical questions identified by policy makers independently of political agendas.	E, D	161
Academic	The political influence, which might ignore results or impose criteria or constraints that produce only the results or interpretation of results that is desired. That is, turns what should be objective into subjective.	U	164
Academic	1) Belief systems leading to no attempt or practise to ground policy in a knowledge framework. 2) Communications – the simple ability to convey lay outcomes decisions in a common language. 3) Scientist in the main being non-reductionist – see paper by Hollwing [?] Two Cultures of Ecology at www.ecologyandsociety.org Vol 2/Iss/2/Art 4.	K, A	165

Academic	Scientists believing their work is 100% objective and value free, then not communicating their assumptions and constraints and findings sufficiently effectively and Politicians believing their short-term economic goals have first priority.	A, Y	166
Academic	I don't observe a large gap, but the most important factor would be: Inconsistent messages from the science sector, especially where ecologists/biologists without fisheries training extend their research/opinions into fisheries policy advice. This can create opposing views/information/advice from "science" which has the effect of discrediting science information and giving policy makers with little direction.	A	170
Academic	The best scientists avoid policy issues.	-----	171
Academic	The lack of clear policy objectives and associated decision rules.	H	172
Academic	Political agendas	D	173
Academic	Traditionally, scientists who could not maintain a career in research have turned to policy. This is very much changing now, but the 'old guard' yields tremendous power, yet they don't have the scientific expertise to promote good policy.	-----	174
Academic	Unwillingness of scientists to promote a particular policy solution, claiming it is incompatible with "objectivity".	α	176
Academic	Short term politics	R	179
Academic	Communication	A	180
Academic	Differing objectives	K	181
Academic	Different time scales. Policy makers do not consider the long term picture enough.	G	182
Academic	Policy makers having little interest in scientific research.	Y	190
Academic	The assumption of scientific advice as a convergence of laws.	-----	191
Academic	Ignorance and poor training (in logic) of policy-makers AND intrusive role of "environmentalists".	Y, D	193
Academic	Uncertainty of results	C	194
Academic	The short-term interests of advisers to the minister.	D	195
Academic	Different agendas. Lack of communication/acceptance	K	196

Academic	It is the different drivers between politics and science. Science seeks the truth, politics seeks reelection. They often drive in different directions politics (the holder of the podium) winning out. One only has to look at the Bush administration's recent handling of the climate change issue at the EPA. Similar examples abound in Australia. If the science does not support reelection (ie to take it might mean unpopular decisions) then our current administrators will ignore it.	K	197
Academic	The short term nature of policy frameworks.	R	199
Academic	Lack of communication on both parts. Some advances are being made i.e. SMP	A	200
Academic	The predominance of dollar values over other values in our society, linking to short-term focus on what the likely outcome will be if a particular decision is implemented.	X	202
Academic	Policy makers unable to comprehend the variation in ecological and evolutionary processes.	Y	207
Academic	Short-term thinking	R	224
Academic	Lack of funding and training in marine science.	E	225
Academic	Science is seen as 'just another stakeholder' to be balanced against competing interests. I lean towards the "no economy without environment" argument – good science which supports <u>sustainability</u> – should have a more important place in policy development.	Y	227
Academic	Inappropriate use of science by policy makers/managers and politicians.	U	229
Academic	Lack of knowledge of related or opposing (science or policy) discipline.	F, Q	231
Academic	Lack of strong effective communication. Policy makers need to define questions better. Scientists need to report results in a way that policy makers can understand.	A, L, T	233
Academic	Industry influence on policy	D	234

APPENDIX 7

Q. 20 verbatim answers and coding for the question:
'What would you change in the relationship between science and policy?'

Note: This is a *verbatim* transcription of the written answers given by the respondents.
It has been carefully vetted and any errors of grammar or spelling are those of the survey respondents.
The use of capitals, underlining, arrows, quotation marks &Co., are what the respondents used to emphasize their thoughts.

Q. 20 Factor Key

A - More scientific research with a focus on policy context and policy needs.
B - Greater interaction and integration between scientists and policymakers.
C - Better communication between science and policymakers.
D - Embed researchers in policy and *vice versa* for real world experience.
E - Policy needs to have longer term vision and resist short-term politics.
F - A greater understanding by scientists of policy process and requirements.
G - Scientists being prepared to engage in public debate on contentious issues.
H - Policymakers asking clearer questions.
I – Make decision-makers more accountable.
J - Scientific funding independent and less reliant on industry support.
K - Measurable environmental objectives.
L - Get more scientists into policy-making bodies.
M - Align long-term research and policy strategies.
N - Policy can better accommodate uncertainty.
O - Change timeframes so that policy people stay longer in a role.
P - Minimize political/vested interest interference with science/policy process.
Q- Encourage policy areas to engage staff with scientific credentials.
R - Recruit professional resource managers instead of career public servants.
S - A greater understanding of science by policymakers.
T - Good independent science should be the basis of policy.
U - Recognize that science advises, it does not set objectives.
V - Involve all stakeholders in decision making.
W - Greater attention to the UN as a source of neutral science and policy.
X - More openness and transparency in the processes.
Y - More scientifically trained politicians.
Z - Integrate more fully the science requirements in policy management.
α - More independence of policymakers from Govt to stop the use of selective science.
β - Agreed environment parameters so that economic value and the environment are protected.
γ – Bring industry and science closer in a more collaborative way for research.
η – Keep scientific advice independent from the influence of policymakers.
μ - More funding for broader, longer-term, ecosystem/biodiversity research.
π - Remove political and industry representation on research boards.
φ - Be clear about what questions science can answer and what it cannot.
----- Indeterminate answer, not used.

Sector	What would you change in the relationship between science and policy?	Factor	Respondent
Govt policy	Greater interaction between scientists, policymakers and resource-users regarding the differences between how each group understands the problem and how each group examines its own behaviour/work.	B	19
Govt policy	Make decision makers more accountable and pay them appropriately for what can be very high levels of responsibility in managing irreplaceable natural resources. Institutionalise engagement and transparency between scientists and policy/govt. Connect managers pay to the sustainability and profitability of the resources they manage!	I, B, X	20
Govt policy	Get academics to undertake real world work experience across the whole gambit of the discipline they are working on – e.g. work with industry, government policy and law makers as well as with the science community. There are too many tertiary institutions that are sheltered workshops and they need to focus on providing answers to the questions that managers/policymakers are asking, not working on things that are sexy or to which they think they have the most chance of getting funding to work on. Managers/Policy makers must also accept responsibility and try to work with and encourage scientists in designing, executing and developing work of relevance.	D, I	21
Govt policy	I would make scientific funding less reliant on industry/management support.	J	26
Govt policy	Reading of advice in relation to uncertainty.	N	28
Govt policy	Embed researchers in the policy world and vice versa.	D	29
Govt policy	Policy needs to be more pro-active with longer over-the-horizon vision and science needs to be more responsive to the policy needs of the day.	M, A	30
Govt policy	Closer links – especially in formulating research directions and priorities.	B, Z	31
Govt policy	More research with focus on policy context and what is do-able.	A	34
Govt policy	More support for scientific programs to support policy.	A	35
Govt policy	A greater understanding by scientists of the needs of policy makers when providing their advice.	F	36

Govt policy	-improved communication and understanding between scientists and policy makers, -greater accountability for the provision of advice and decisions that flow from this, -minimise political interference in the science/policy process.	C, I, P	37
Govt policy	Honesty in the scientific process. Be open about what they do not know about.	C, X	38
Govt policy	More strategic research that is targeted towards meeting policy of man questions – having those drive or influence res. Priorities (to some extent). Make research more relevant.	A	39
Govt policy	Open forums, workshops, public questions, keynote speakers on sustainable fisheries management. Identify the barriers limiting the uptake of new innovations and holistic long term focus by science and policy makers.	C, Z	40
Govt policy	Political acceptance that a longer term view is needed (for policy and research) rather than answering the immediate "bushfires" in Sci. or policy.	M	41
Govt policy	Stronger linking between policy objective setting and allocation of funds to meet policy management decision making for science.	Z, M	42
Govt policy	Improve the leverage i.e. go for stronger scientific outcomes by employing focussed research and then lock that into policy decisions.	Z, M	43
Govt policy	More outcomes (in a policy development sense) based research focussed on triple bottom line rather than scientific self indulging and paper based research (scientific/PhD's).	A	45
Govt policy	More details on social effects before policy is implemented rather than after.	V	46
Govt policy	From my previous answer, economics needs to be added to the relationship.	-----	48
Govt policy	Policy makers need to frame policy needs and resultant questions. Researchers then need to develop commissioned research projects to address those questions. All research data must be based on a 'theory of action' with defined 'route to market'.	H, Z	49
Govt policy	I would introduce measurable objectives for what Australia wants for its environment.	K	53

Govt policy	I'd improve the flow of information.	C	54
Govt policy	It's better than you might think here in Australia. Some scientists need to appreciate that the world does not operate on scientific facts alone. Not much to change, just clearer understanding between scientists and policy makers.	C	57
Govt policy	Get more scientists into policy making bodies.	L	59
Govt policy	There needs to be an improved understanding between scientists and policy officers. This can be done by having scientists and policy officers working together rather than totally independently.	C, B	60
Govt policy	Give stronger emphasis on clear long-term goals which will resist short-term political interference.	E	65
Govt policy	Communication.	C	66
Govt policy	Increased communication between science and policymakers.	C	69
Govt policy	Exposure of policy officers to research methodologies including fieldwork experience and exposure of research staff to policy development requirements.	D	70
Govt policy	Promote more discourse.	C	73
Govt policy	Improve communication channels between the two groups.	C	74
Govt policy	As in some fisheries – align 5-10 year research and policy strategies.	M	75
Govt policy	Creation of mechanisms to improve dialogue between scientific community and policy makers so that longer term priorities can be set iteratively and appropriately funded.	C, M	76
Govt policy	I would ensure that science provides an objective assessment of the range of options (both positive and negative). This would enable policy makers to base decisions on an understanding of the risks and implications of a decision.	B	86
Govt policy	A change in attitude because in the end both sides are working towards the same goal.	C	87

Govt policy	I want to see a more holistic approach that recognises interdependencies. For example, your question 10 does not work for me as I think all these values are inter-dependent. I find ranking them a very artificial exercise. For example economic values often depend on biodiversity values. Science AND policy need to better recognise these interdependencies and consider the whole human/ecological system.	-----	89
Govt policy	Have more policy-setting organisations with a science wing, to bring the two fields closer together.	B	90
Govt policy	Closer working relationship	B	95
Govt policy	To be useful to policy, scientific research needs to be focussed on providing that will lead to practical, on-ground solutions as quickly as possible.	A	98
Govt policy	Closer working relationships between scientists and policy makers in which scientists aimed to better understand the information needs of policy makers, and developed a commitment to supporting those needs. Scientists generally tend to be either policy-ignorant, or policy experts, rather than what they should be aiming for: policy-relevant.	B, F	99
Govt policy	Job exchanges – once you live in each other's needs, you see the differences.	D	101
Govt policy	Science shouldn't invest in research that can't answer the questions they're seeking. Policy makers won't continue to contribute funds when the answers coming back are constantly "we can't be sure, we need more money".	φ	102
Govt policy	Improve articulation of policy goals before developing detailed policy.	H	106
Govt policy	Scientist's ability to communicate the relevance of their science.	C	109
Govt policy	Increased interaction and openness.	B	110
Govt policy	Change way research questions are proposed to include references/recommendations to management that are achievable in todays society, not a Utopian one.	-----	111
Govt policy	I would like all scientists undertake a short course on the APS and policy development and how they fit into the policy development process. Why? Well to assist scientists in making more targeted recommendations.	F	113

Govt policy	Scientists being prepared to "stand up" and be counted in public debate and contentious issues. Too often, scientists do not engage in public debates on controversial issues, leaving policy makers to do this. Established scientists should use their credentials as credible scientists (with extensive knowledge in an area) to explain the results in the public domain.	G	115
Govt policy	Policy makers to ask clearer questions. Scientists to consider bigger picture and implications.	H, F	116
Govt policy	Better/stronger collaboration. Research conducted to assist in developing policy.	B, Z	120
Govt policy	Use the state or Commonwealth Chief Scientist in a more active role.	G	130
Govt policy	Communication – with respect to relevance of science, prioritising, communicating progress and results of science.	C	146
Govt policy	Change the time-frames so that policy people remain in a role long enough to really get to grips with the topic. Change the view that policy positions are just a step up the ladder. Change the reward system to encourage scientists to do more practical research.	O	167
Govt policy	Policy can better accommodate the uncertainty inherent in science.	N	177
Govt policy	Integration of the policy-scientific process instead of the current us vs them approach.	B	208
Govt science	Improve communication between scientists and policy makers.	C	24
Govt science	Train and recruit professional resource managers instead of bureaucrats who are more focussed on admin and enhancing their public service careers.	R	27
Govt science	Clearer performance indicators for fisheries. Managers can then make policy decisions based purely on whether these performance indicators trigger in a positive or negative direction. In conjunction with these PI's there needs to be a clear set of actions that are taken when they trigger.	R	33
Govt science	Increase funding to cover transaction costs.	-----	63
Govt science	Increase communication and interaction possibilities – This requires funding support for increasing participatory negotiation mechanisms.	C, B	93

Govt science	Make the science independently funded.	J	97
Govt science	Put in place people who understand the processes but who have no agendas. I wish!	R	123
Govt science	Improve the communication/understanding btwn Science and policy.	C	131
Govt science	Essential that one retains independence both through institutional structures and by the scientific community.		132
Govt science	Require face-to-face explanation and Q&A	C	139
Govt science	Greater understanding of science by policy makers. How it works and how it can help them.	S	140
Govt science	Ensure that policy makers know the subject. Make ministers professional appointments – not politicians.	R, S	141
Govt science	Much greater communication between managers, and policy makers, involving regular meetings where issues are discussed in detail. At present, the decisions are made in the absence of discussion with scientists, based only on their journal input.	C	142
Govt science	Get policy makers to view uncertainty as a statement of honesty rather than a statement of lack of commitment.	M	144
Govt science	Improve communication at all levels, remove political/ministerial influence (Ha!)	C, P	147
Govt science	Involvement from the initiation of discussions to ensure all key people (specialists) are consulted and that long term effects are taken into account.	V	148
Govt science	Encourage policy areas to engage more staff with scientific credentials.	Q	149
Govt science	Scientific evidence needs to be given greater prominence, and needs to be accepted as the dominant filter (ie given priority) in decision-making	T	151
Govt science	Sound science drives policy not vice versa.	T	154
Govt science	Better communication/collaborations	C, B	159
Govt science	Educate the managers and policy makers to the same level as scientists.	S	160
Govt science	Recognise that science advises, it does not set objectives.	U	168

Govt science	- Improve communication (dialogue!!!) between science and policy. - Policy-makers to define research needs to engage science providers in undertaking targeted research. - Policy-makers to learn to as the right questions of scientists.	C, A, H	169
Govt science	Increase funding to long term projects to provide objective information referenced against longer time frames and if poss with ecosystems based approach.	J	175
Govt science	Increased communication	C	178
Govt science	Education of policy makers	S	183
Govt science	More long term "over the horizon" research.	M	184
Govt science	Quality control on decision making. Independent review	-----	185
Govt science	1) Remove (or separate) management agencies from science and research. E.g. Fisheries management agencies in Australia are also responsible for research – this is a major conflict of interest. 2) Make science the basis of policy decisions (rather than economic). 3) Better communicate scientific outcomes to managers and the general public.	T, C	186
Govt science	Create cross-institutional or cross-cultural organisations including the best scientists and policy makers (not mid-level to bureaucrats) to come up with a joint approach to conducting scientific research to inform the policy process.	M	187
Govt science	Develop an understanding amongst policy makers that uncertainty is a fact of life to be cherished and embraced and objectively managed.	N	188
Govt science	1. Scientists and policy makers need to better understand where the other is coming from in their views. 2. More thorough coverage of both areas, and their interaction, at the university graduate level.	D, F, S	192
Govt science	Make policy-makers independent of politicians.	α	201
Govt science	Better communication.	C	203
Govt science	Improved communication	C	204
Govt science	Include scientists in policy making teams	Q	205
Govt science	Independence and better communication.	C	206

Govt science	As previously, it would help to have clear policy questions/information gaps communicated to scientists.	H	209
Govt science	Education of both parties to the role and responsibilities of the other.	D	210
Govt science	Most departments in WA that are responsible for policy or advising on policy do not even read the appropriate scientific literature that is relevant to the decisions they are making. Each department should employ an experienced researcher to access the latest information for wide dissemination. The latest scientific advances could then be considered in the decision making process.	Q	211
Govt science	Make policy makers and managers accountable for their decisions. Most move on to their next position before their incompetence is obvious and others seem to be left to fix the mess.	I, O	212
Govt science	Politics	-----	214
Govt science	Inject scientists into government levels, on rotating basis, and vice versa.	D	215
Govt science	- better communication - more funding for policy relevant science - better recognition for role of science in policy development	C, J, T	217
Govt science	Long term accountability.	I	219
Govt science	<u>Less political influence on decision-making</u>.	P	220
Govt science	Include policy component in the education of scientists.	F	221
Govt science	As long as people make policies, policies will always be corrupt. i.e., I don't know.	-----	222
Govt science	Change political process.	α , P	223
Govt science	Not sure	-----	226
Govt science	Fund longer term strategic science to anticipate future policy requirements, combined with tactical research closely allied with commercial activities to 'calibrate' the influence of present-day activities, or to assist with their move to more environmentally sustainable practises.	M	230
Govt science	1. Fund science for important global environmental problems. 2. Request advice from science for big problems.	T	232

Enviro group	Acknowledge science is political, i.e. not objective, then get on with the job!	-----	47
Enviro group	Remove political and industry representation on research boards. Encourage funding of broader ecosystem research.	π, μ	71
Enviro group	Be clear about the questions that science is capable of answering, and those it cannot.	φ	79
Enviro group	More funding for both pure biodiversity research and research in support of management.	μ	81
Enviro group	Improved communication of scientific findings to policy makers.	C	91
Enviro group	Stronger guidance of policy by science and the precautionary principle.	T	103
Enviro group	The understanding of risk.	-----	104
Enviro group	Improved informed communication of scientific research to public, industry and governments.	C	105
Enviro group	Ensure advice is framed per. Q. 19.	-----	107
Enviro group	A legislative requirement to base decisions on science not politics.	T, η	112
Enviro group	Good independent science should be the basis of policy.	T	114
Enviro group	I would make independent ecological science form the minimum standards approach to marine planning and management, and ensure that all other concerns (economic, industry, social) worked above and beyond this.	T	121
Industry group	Linked to question 24 there although good channels of communication is a must there should be a clear seperation between scientific and policy making institutions. Case in point when the Marine Research Laboratories at Taroona were directly controlled by DPIWE Policy clearly influenced the science reaching the table. Since the formation of TAFI scientific advice is clearly more independent from the influence of the policy makers.	η	2
Industry group	Fresh ideas new people that can make informed decisions! And the policy makers make industry pay for there research to form policy decision (doesn't seem right to me) when independent scientific research is asked for it always comes from industry so how can you call it independent (there is room in Australia for a gov funded independent research body.)	J	3

Industry group	Where scientific advise on species dynamics indicates an acceptable outcome i.e. T.A.C. Remove the political influence from managers ability to manage	η	4
Industry group	If possible – but I am a realist. The first obligation of any government is to stay in power.	-----	5
Industry group	Change "Theory" to Practical	-----	6
Industry group	I think it is healthy	-----	7
Industry group	There needs to be, for ecological management of marine resources and fisheries, agreed parameters of the important features of the environment so that the objective of economic value and eco/environmental protection is achieved. Research should then address the parameters.	β, A	8
Industry group	Policy makers asking clear questions and then having researchers compete to supply the best answer <u>to the question</u>	H, A	9
Industry group	More objective interactions where scientists could better explain methodology and industry could better explain assessments on water.	B	10
Industry group	Bring Industry and science closer in a more collaborative way in designing research programs. Research must be seen to meet with the Practicalities of carrying it through to benefit the Community.	γ	12
Industry group	The people making the policy	-----	16
Industry group	Independent research that is adaptable/more easily interpreted.	η	17
Academic	Perhaps more understanding and trust between the two groups and more weight placed on objective and substantiated advice.	B	18
Academic	Work with Aboriginal and TS Islanders to develop social, cultural and economically sensitive solutions and management programs.	-----	23
Academic	Strengthen the dialogue (formal) between all stakeholders and science – involve all stakeholders in the decision making.	V	25
Academic	Greater attention being given to the UN as a (reasonably) impartial, scientifically excellent, global, politically neutral source of science/policy (FAO, UNEP, UNDP, WHO, UNESCO etc)	W	50

Academic	Make it more dependent upon long-term, as opposed to short-term outcomes.	E	55
Academic	Greater involvement of policy analysts in scientific research.	S	56
Academic	Improved communication of results.	C	58
Academic	If there is scientific certainty in an issue area that policy makers take that advice seriously.	N	61
Academic	Better 2way communication. So: Science has a clearer understanding of how information is used in policy; and Policy has a clearer understanding of the scope of science.	C, D	67
Academic	Increase openness within the processes as far as is practicable.	X	68
Academic	Lead scientists be better educated and skilled in presenting the results of research and its likely effect.	C	77
Academic	Policy should be required to demonstrate either level of certainty or level of uncertainty and policy proponents forced to report triple bottom line.	N	80
Academic	Have more scientifically trained politicians	Y	83
Academic	Embedding policy knowledge in the research community, in formal curricula and professional development.	F	84
Academic	Make it clearer at the outset of a policy development what weight is to be attached to the science before the results come in.	Z	85
Academic	Integrate more fully the science requirements in policy management. Encourage longer TIME frames than that supported by the electoral cycle.	Z, E	92
Academic	Place scientists on the boards of policy makers.	D	94
Academic	Research scientists need professional training in policy. Policy makers need to understand the approach and nature of science: what it can and cannot do/say. A real problem is that the two groups come together on specific issues and prejudices are formed from misunderstandings… if they knew more about each others approaches.	F, S, B	96
Academic	Research question design and funding methodology	-----	118

Academic	Change democratic process → rolling election of representatives → 10-15 year terms → insist on elected representatives undergoing training in environmental, social and economic issues → increased use of bi-partisan committees in decision-making.	-----	119
Academic	Have the policy process give scientists given questions they can have a hope of answering. More to a policy framework where lack of full knowledge is recognised, but is not an inhibitor to action. Scientists have already neutered the Pre. Principle – they can subvert anything!	A	122
Academic	Policy power given to longlife stat. authorities with a strong scientific component instead of shortterm politically driven departments.	R	127
Academic	Access to facts.	-----	128
Academic	Nothing	-----	133
Academic	Give more emphasis to science in support of sustainable, healthy and properly functioning ecosystems.	T	135
Academic	Working environment where managers and scientist exist together. CSIRO in Hobart and AFMA in Canberra is nuts.	B	138
Academic	Policy makers should base their decisions on science. Long term views/policies (over a number of generations) should be applied by policy makers.	T, E	152
Academic	I would give more emphasis to consultation/facilitate communication.	C	153
Academic	Focus on long-term thinking.	E	155
Academic	Better communication of what is needed, how to provide it, what the data means, etc.	C	158
Academic	More independence of policy makers from government bodies so less pressure on them to pick and choose which science they will accept, irrespective of results.	α	161
Academic	The reliance of scientific research on funding, and the "social philosophy". The latter usually is that it does not matter what we do to alter our environment, we have the knowledge and power to either fix it or change it to suit our needs.	-----	164

Academic	1. Science is accepted as a cornerstone of policy – see Moreton Bay Waterways and Catchments Partnership Model – www.healthywaterways.org – for an example of this. 2. But then policy defines what science is needed to get better policy. Cf. adaptive management approach. Policy is the client, science the service provider.	T, A	165
Academic	More scientists contributing to the formulation of policy and strategy for implementation, and more politicians meeting with scientists and learning about science and understanding the need for longer term goals.	L, S	166
Academic	Scientists need greater voice in shaping policy direction, rather than tuning details.	L	170
Academic	Have well-funded prestigious science review panels (convened by AAS) to provide definitive synthetic advice.	T	171
Academic	Work towards development of policy objectives that take account of biological, economic and social inputs.	-----	172
Academic	Empowerment of scientists in political decision-making process.	L	174
Academic	Cross-disciplinary training for both scientists and policy-makers, beginning early in their respective careers.	F, S	176
Academic	Educate scientists about policy and vice versa	F, S	179
Academic	Improve communication and understanding of the environment and pressures on each stakeholder group.	C	180
Academic	Increased involvement by policy makers in directing/funding scientific research W/ direct policy application (inc. better communication)	A, C	181
Academic	More interaction at workshops/conferences typically very few policy seminars at conferences to inform scientists of the issues and direct research into relevant areas.	C	182
Academic	Have policy directed to science as well as economic and society needs.	-----	190
Academic	I guess that there is a need for independent and able persons that can link high-level politicians and scientific advisers.	C	191
Academic	Replace science managers with trained managers. Replace political managers with properly trained scientists.	D	194

Academic	A senior scientist to interpret advice to the relevant minister in person.	-----	195
Academic	Ratio of science vs political evidence in decision making. Increase communication. Cross-disciplinary agendas.	T, C	196
Academic	Education of the Australian electorate is critical. Despite the silly slogan 'the clever country' we are largely an uneducated people. People shy away and almost despise science – this translates into the election of politicians who give out simple, non-scientific messages. Science can be ignored as people don't look for it.	-----	197
Academic	Increased training about science for policy makers.	S	199
Academic	Get the 'boffins' out of the lab!	D	200
Academic	Pie-in-the-sky? The emphasis in our society on the individual and what he/she can attain to the individual within our society – i.e. what is best for our society not just the individual. More realistically, improve the appreciation or understanding of scientific thinking per se in our society → Get more people to incorporate scientific thinking as PART of their own thinking.	-----	202
Academic	Scientists are nowadays difficult to survive because they are controlled by politicians and managing people. They cannot get a decent job reasonably well. They spend too much time for applying funding with very little hope and following managing people's rule to this and to do that. Scientists' social status are not high and paid too low. Nobody understands how much effort a scientist puts in to get a result or a paper done and of course the importance to the society. Politicians and policy-makers are usually short-sighted as they do not like science firsthand but chose politics or social subjects during their early age. I have to say there is no real solution to fill the gap since it is determined by the social system.	-----	216
Academic	Strong statutory requirement on decision-making ('due') process.	-----	224
Academic	More scientists involved and less industry and community involvement.	π, P	225

Academic	All sectors of society profess to want sustainability outcomes. Environmental sustainability is the key to economic and social sustainability. Policy makers must give more weight too achieving the former ahead of the latter. This requires policy to be developed in close consultation with scientists.	T	227
Academic	Better communication and more open processes	C, X	229
Academic	Work on <u>delivering</u> the knowledge to the other discipline.	B	231
Academic	Have more frequent/effective interaction between policy makers and scientists. Cross disciplinary training.	B, D	233
Academic	Make politicians less corrupt.	P	234

APPENDIX 8

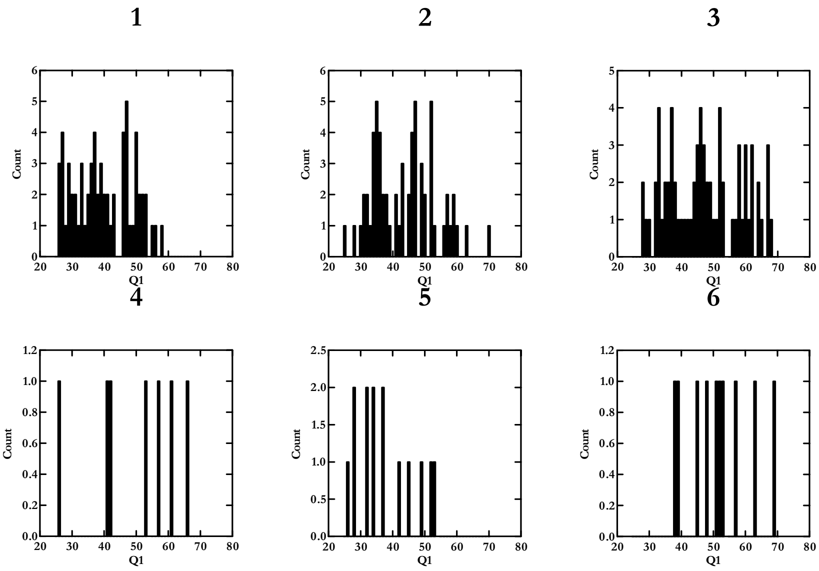
Survey 'Other Comments'

Work Sector	Other Comments	Respondent
Industry group	Note the difference between environmental movements and industry lobby. Ignoring the intuitive "goodness" surrounding the environmental movement their methods do not (and rarely!) require scientific rigour. Their approach is to sway public opinion regardless of the truth of their argument. Industry lobby (in my experience) fund and find out what the facts are in order to determine a case. Environmental lobbies often search for 'facts' to support their case	5
Industry group	Despite the problems, the science/policy/industry interface is better in Australia than in most countries, except perhaps NZ, Chile and Iceland.	10
Industry work	From an industry perspective, scientific research documents need to be more user friendly to facilitate in clear policy making. (This also goes for surveys with wordy questions that require a dictionary for John Citizen!) Good luck with the PhD, hope you get some worthwhile results!	17
Govt Policy	Potentially a very useful piece of work, there is a lot of $ and effort put into science and very few people taking responsibility for using the resultant knowledge. Scientists say its managers, managers say the opposite. It should be both collaboratively! I would be happy to discuss in more detail. I look forward to the report and its uptake! [*JS: No contact details supplied with the returned survey.*]	20
Academic	While filling out this survey, I kept thinking of the IWC and the 'scientific' evidence used for whaling. It demonstrates that scientific results can be skewed to support cultural, economic and political positions.	61
Govt Policy	When asked to answer or contribute to answering policy questions science often comes back with an answer that either says something might still happen, or that there are several answers to the question. This often perpetuates policy paralysis (i.e. not taking a decision). What science needs to provide is a quantification of the implications of taking a particular decision or choosing an option (either through evaluating the consequences of a decision being wrong or assessing the probability of a negative consequence actually happening). This outcome would be a consequence of both science giving the right answer and policy asking the right questions.	86
Enviro Group	Traditional knowledge is very important, valuable and necessary – both knowledge of natural systems and cultural knowledge – traditional and Western scientific knowledge need to go hand in hand to inform policy.	100
Govt Policy	I held the role of science/policy liaison office at AAD for a period of time and would be to discuss lessons learned if my name/job etc are not acknowledged… --- [*JS – This person was not interviewed*]	113

APPENDIX 9

The complete survey questions and results.

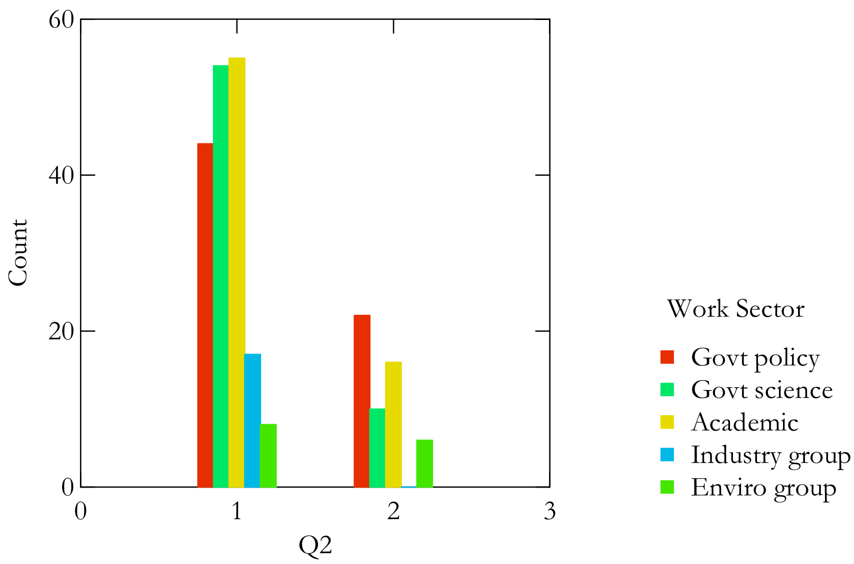
1. What is your age? _________(years)



1 = Govt policy; 2 = Govt science; 3 = Academic;
4 = Industry group; 5 = Enviro group; 6 = Industry work.

	Total	Minimum	Maximum	Median	Mean	s.e.
Statistics	229	25	70	44	43.838	0.707

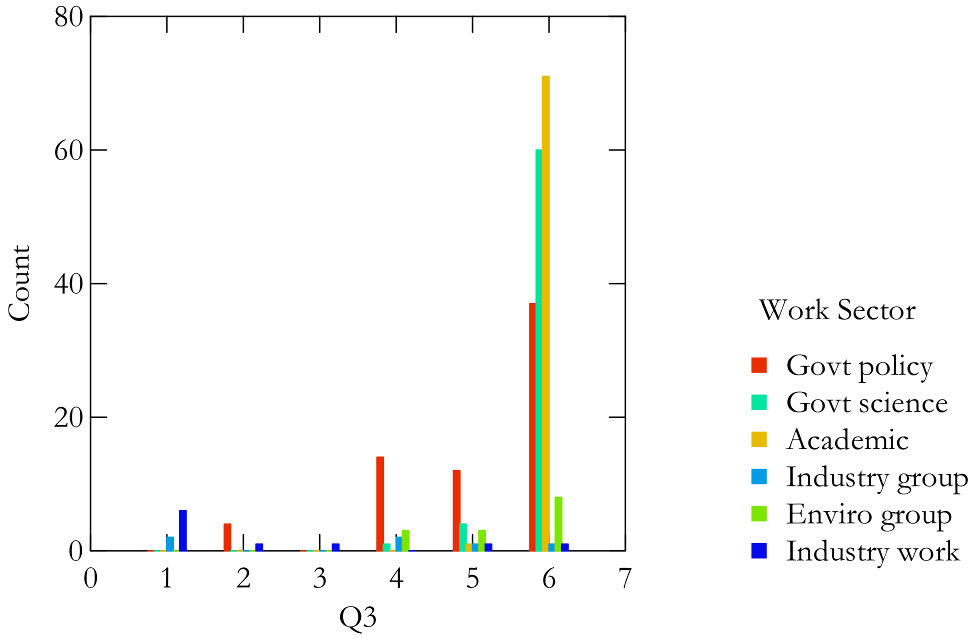
2. Gender? Male = 1 Female = 2



	1 = Male	2 = Female	Total
Frequency	178	54	232
Percentage	76.724	23.276	100

3. What is the highest level of education you have completed?

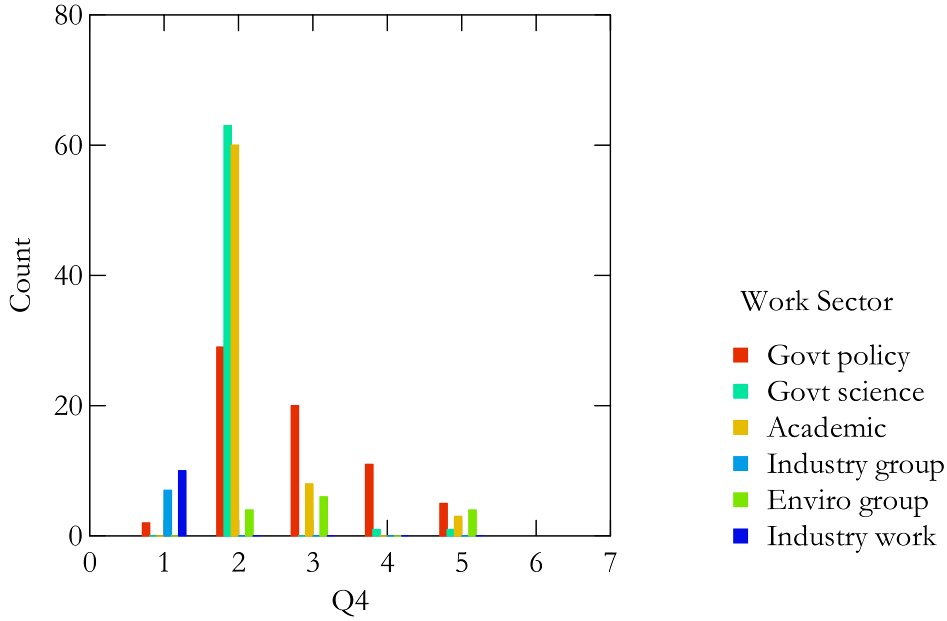
High school certificate (year 10)	1
High school matriculation (year 12)	2
Trade or TAFE qualification(s)	3
University undergraduate degree	4
University Honours degree	5
Post-graduate qualification	6



	1	2	3	4	5	6	Total
Frequency	8	5	1	20	*22*	**178**	234
Percentage	3.419	2.137	0.427	8.547	9.402	76.068	100

4. Your background is in?

Commercial fishing	1
Science	2
Policy	3
The public service	4
Other	5

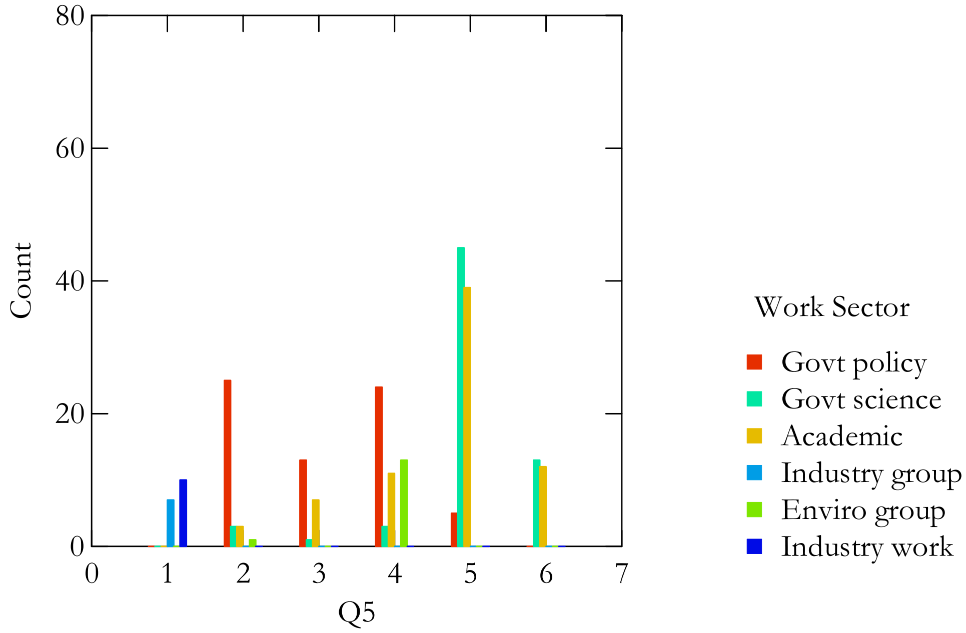


	1	2	3	4	5	Total
Frequency	19	**156**	*34*	12	13	234
Percentage	8.120	66.667	14.530	5.128	5.556	100

Respondent	Q. 4 'Other' background work	Current Sector
18	International law	Academic
19	Law	Govt policy
40	Natural resource management	Govt policy
47	Activism	Enviro group
53	Law	Govt policy
59	Navy	Govt policy
65	Economics	Govt policy
71	Wildlife management	Enviro group
77	Law	Academic
93	Education	Govt science
100	Conservation	Enviro group
114	Environment	Enviro group
118	Law	Academic

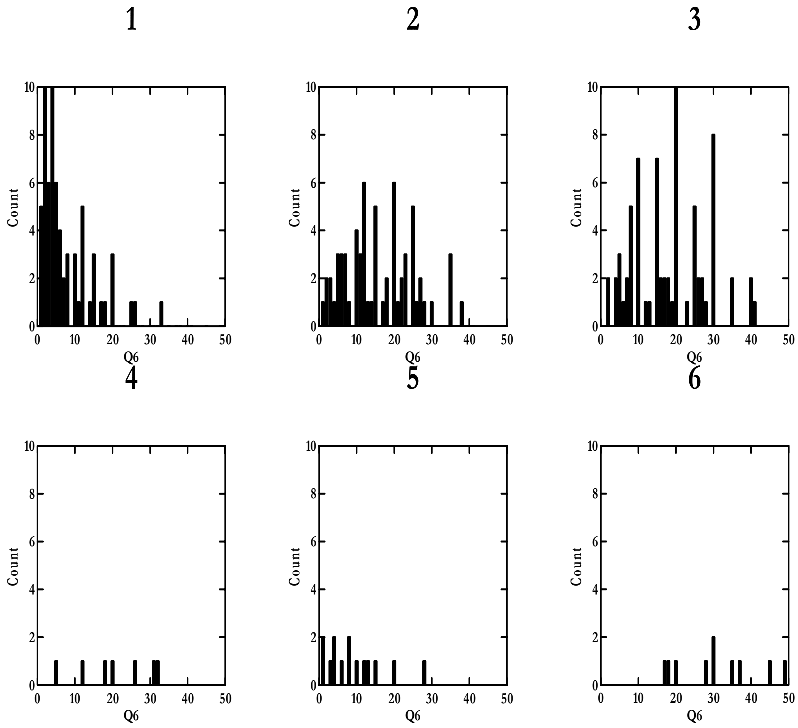
5. Your present work is primarily in?

Commercial fishing	1
Fisheries management	2
Marine resource policy	3
Marine environment policy	4
Marine biological sciences	5
Marine physical sciences	6



	1	2	3	4	5	6	Total
Frequency	17	32	21	*51*	**89**	25	235
Percentage	7.234	13.617	8.936	21.702	37.872	10.638	100

6. How long have you been doing this work?_________(years)

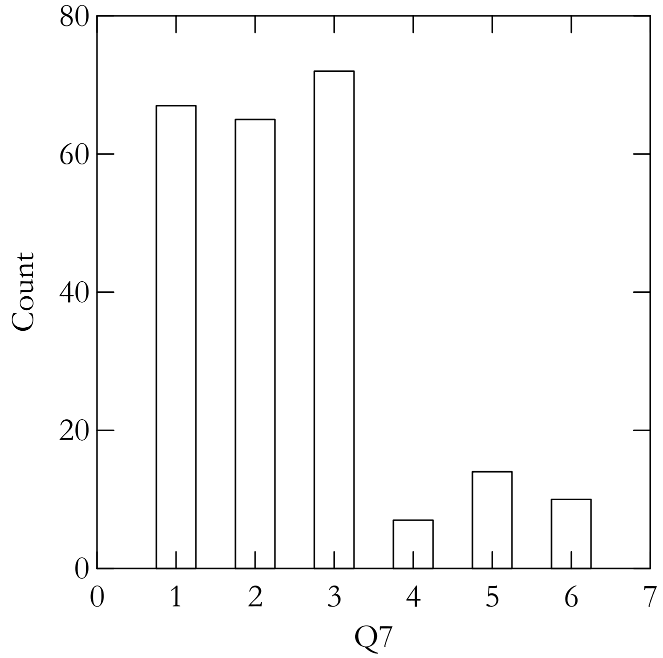


1 = Govt policy; 2 = Govt science; 3 = Academic;
4 = Industry group; 5 = Enviro group; 6 = Industry work.

	Total	Minimum	Maximum	Median	Mean	s.e.
Statistics	235	1	49	12	14.715	0.679

7. The sector in which you work is?

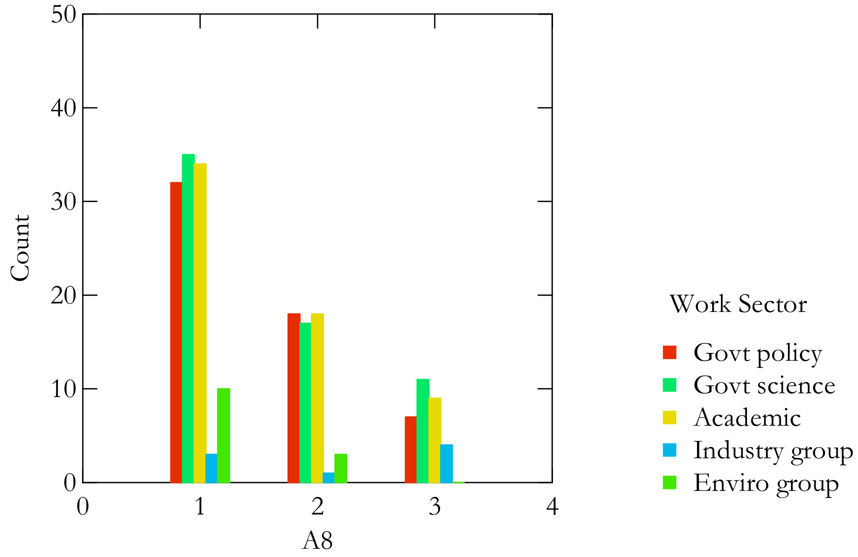
Commonwealth or State policy service delivery	1
Commonwealth or State science research	2
Academic institution	3
Industry advisory / representation / lobbying group	4
Environment advisory / representation / lobbying group	5
Private business / industry	6



	1	2	3	4	5	6	Total
Frequency	65	*67*	**72**	7	14	10	235
Percentage	28.511	27.660	30.638	2.979	5.957	4.255	100

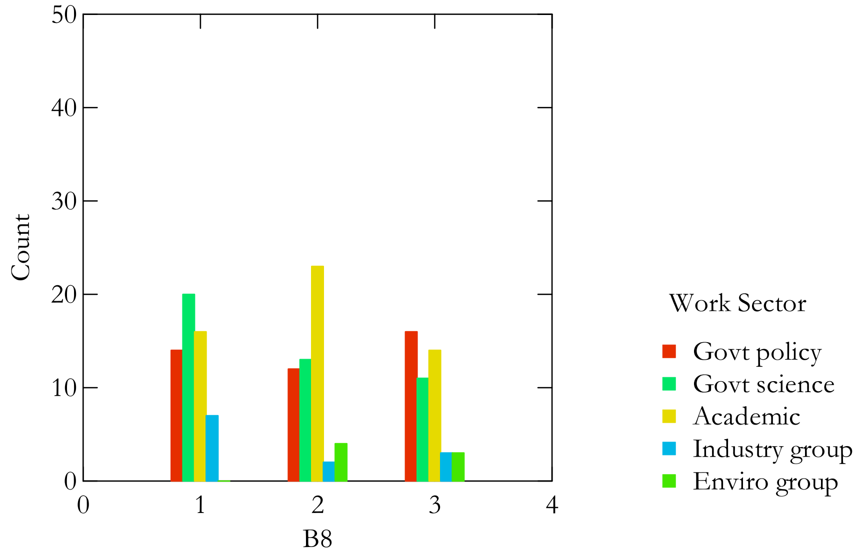
8. From the following, please rank what you believe are the three most major human effects on marine biodiversity. (1 = most effect; 3 = least effect)

Commercial fishing



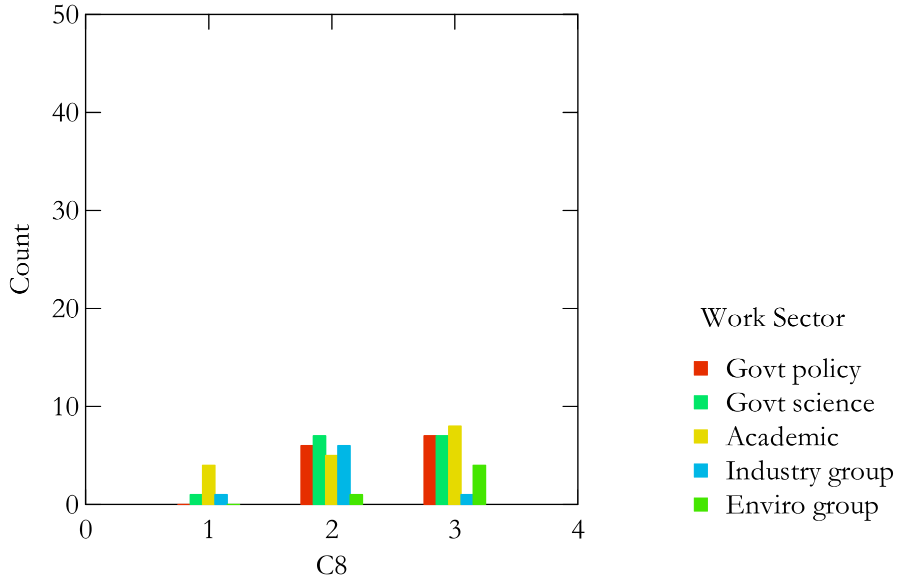
	1	2	3	Total
Frequency	**114**	*57*	13	202
Percentage	56.436	28.218	15.347	100

Pollution



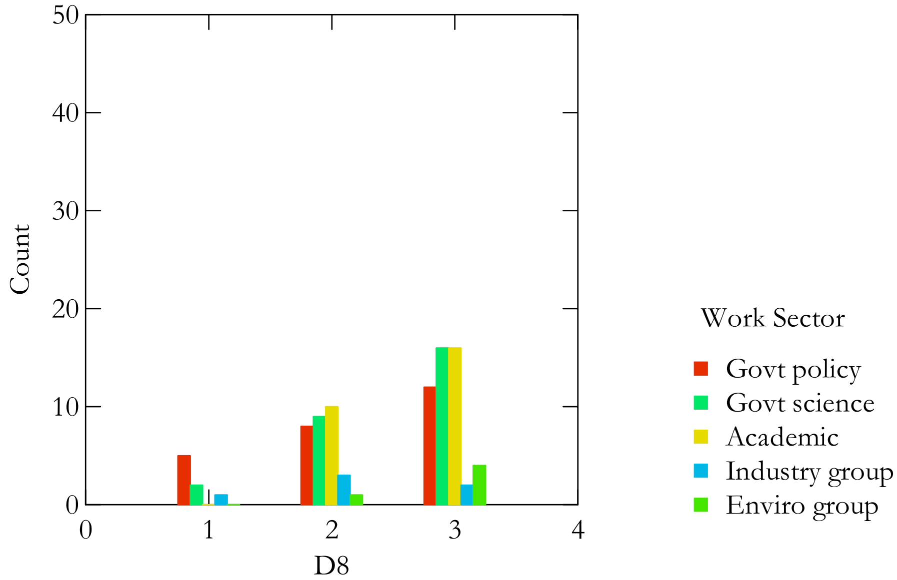
	1	2	3	Total
Frequency	**57**	*54*	47	158
Percentage	36.076	34.177	29.747	100

Recreational fishing



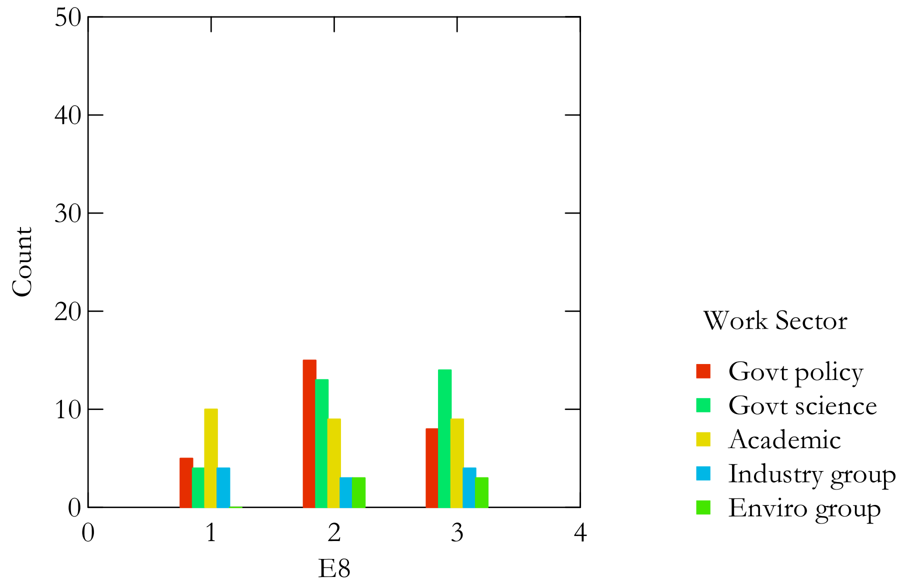
	1	2	3	Total
Frequency	6	*25*	**27**	58
Percentage	10.345	43.103	46.552	100

Exotic species



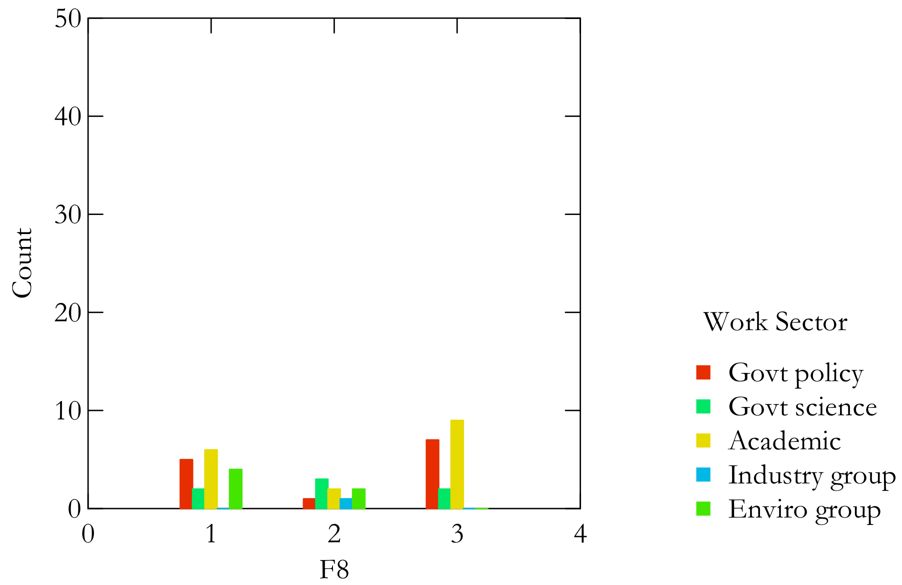
	1	2	3	Total
Frequency	8	*31*	**50**	89
Percentage	8.989	34.831	56.180	100

Illegal, unregulated and unreported fishing



	1	2	3	Total
Frequency	23	**43**	*38*	104
Percentage	22.115	41.346	36.538	100

Other effect

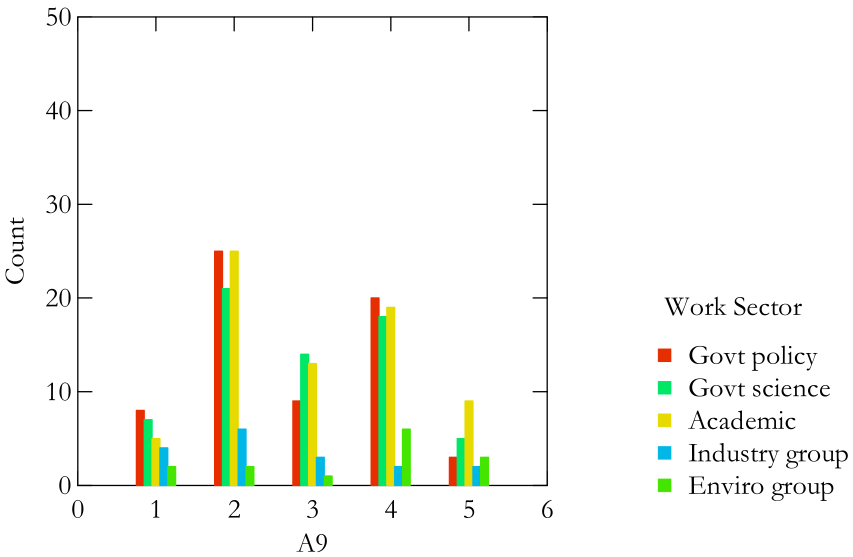


	1	2	3	Total
Frequency	*17*	9	**18**	44
Percentage	38.636	20.455	40.909	100

Respondent	Q. 8F 'Other Effect'	Ranking	Sector
25	Habitat modification	1	Academic
30	Coastal development and the cumulative effects of all factors listed in the question	1	Govt policy
55	Habitat destruction	1	Academic
72	Climate change	1	Enviro group
73	Global climate change	1	Govt policy
88	Habitat degradation	1	Academic
89	Climate change	1	Govt policy
99	Climate change	1	Govt policy
100	Climate change	1	Enviro group
102	Climate change	1	Govt policy
104	Climate change	1	Enviro group
105	Climate change	1	Enviro group
158	Climate change	1	Academic
159	Global climate change	1	Govt science
166	Habitat alteration	1	Academic
204	Climate change	1	Govt science
221	Climate change	1	Academic
4	Coastal development	2	Industry work
24	Habitat degradation	2	Govt science
33	Habitat degradation	2	Govt science
49	Catchment alteration/degradation	2	Govt policy
79	Climate change	2	Enviro group
91	Climate change	2	Enviro group
155	Runoff/sediments	2	Academic
170	Damaging gear used by either rec, commercial, or indigenous sectors.	2	Academic
28	Coastal development	3	Govt science
51	Land and coastal management	3	Govt policy
67	Cultural alienation whereby the seas are seen as infinite, marine creatures abundant and a lot threatening, so a failure to see needs for maintaining marine biodiversity and resources.	3	Academic
80	Effects of terrestrial activity on adjacent marine environments.	3	Academic
101	All fishing – or at least fisheries overuse.	3	Govt policy
106	Global warming	3	Govt policy
110	Global warming	3	Govt policy
116	Climate change	3	Govt policy
117	Climate change	3	Govt science
144	Human-induced climate change	3	Govt science
161	Habitat loss	3	Academic
191	Coastal development	3	Academic
193	Global climate change	3	Academic
199	Terrestrial agriculture	3	Academic
208	Habitat damage	3	Govt policy
216	Mismanagement	3	Academic
227	Catchment degradation on marine habitat	3	Academic
231	Building	3	Academic

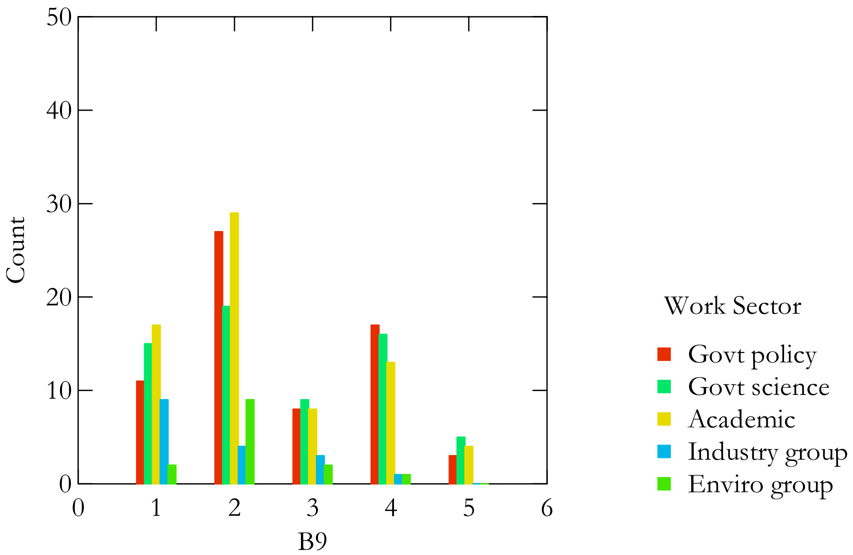
9. For the following statements, please circle your level of agreement using this scale: 1–strongly agree; 2–moderately agree; 3–neutral; 4–moderately disagree; 5–strongly disagree.

a. The precautionary principle plays a major part in marine policy.



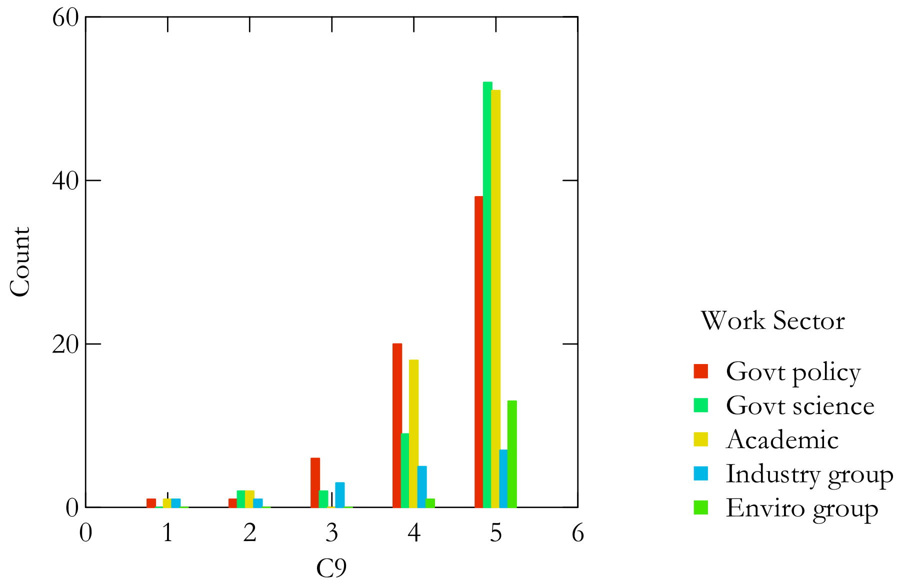
	1	2	3	4	5	Total
Frequency	26	**79**	40	*65*	22	232
Percentage	11.207	34.052	17.241	28.017	9.483	100

b. Scientific uncertainty reduces the effectiveness of policy decisions.



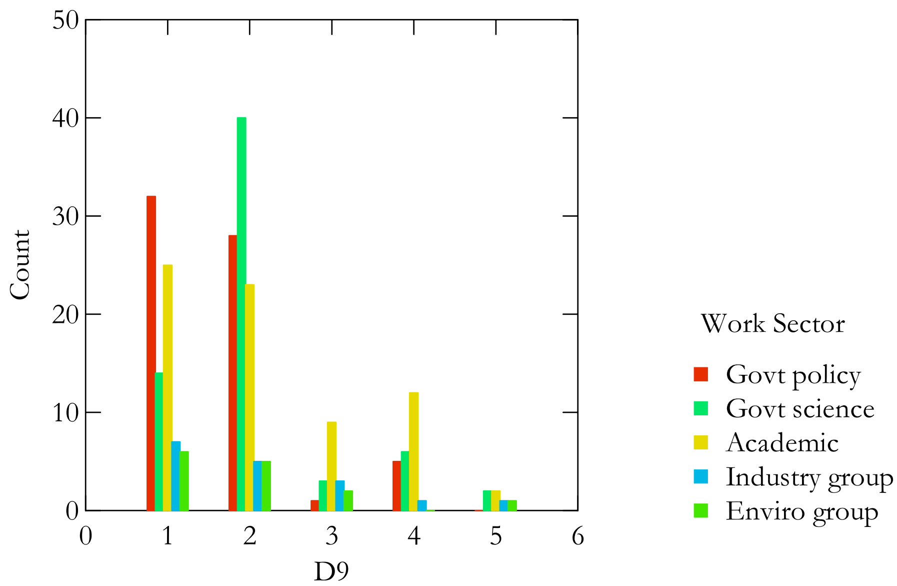
	1	2	3	4	5	Total
Frequency	*54*	**88**	30	48	12	232
Percentage	23.276	37.931	12.931	20.690	5.172	100

c. Overfishing is not a problem; we can rebuild fish stocks.



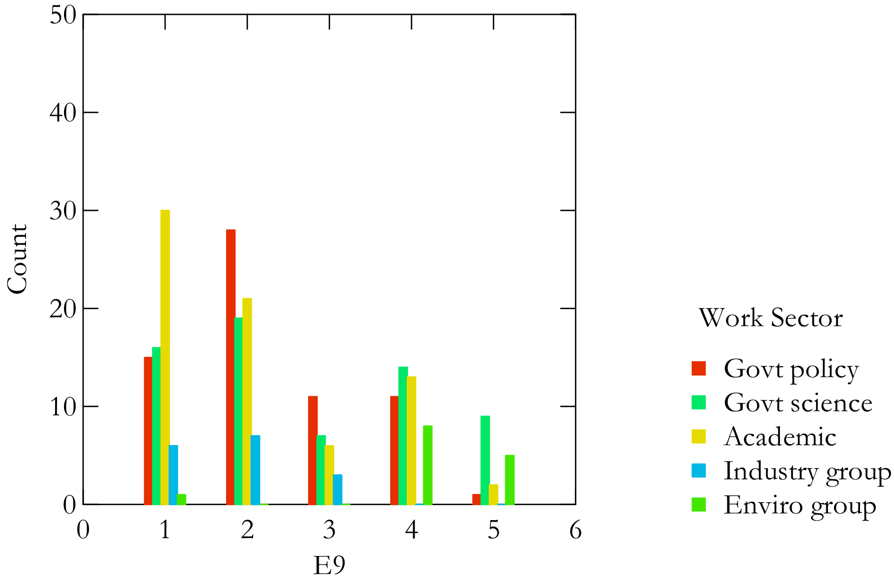
	1	2	3	4	5	Total
Frequency	3	6	11	*53*	**161**	234
Percentage	1.282	2.564	4.701	22.650	68.803	100

d. Science cannot answer all the needs of policy.



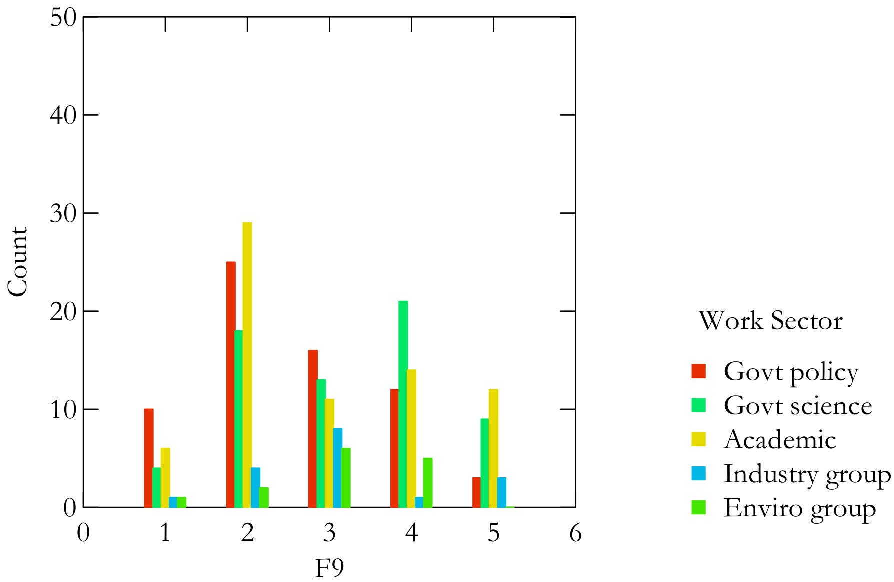
	1	2	3	4	5	Total
Frequency	*84*	**101**	18	24	6	233
Percentage	36.052	43.348	7.725	10.300	2.575	100

e. Policy should balance industry needs with ecosystem protection.



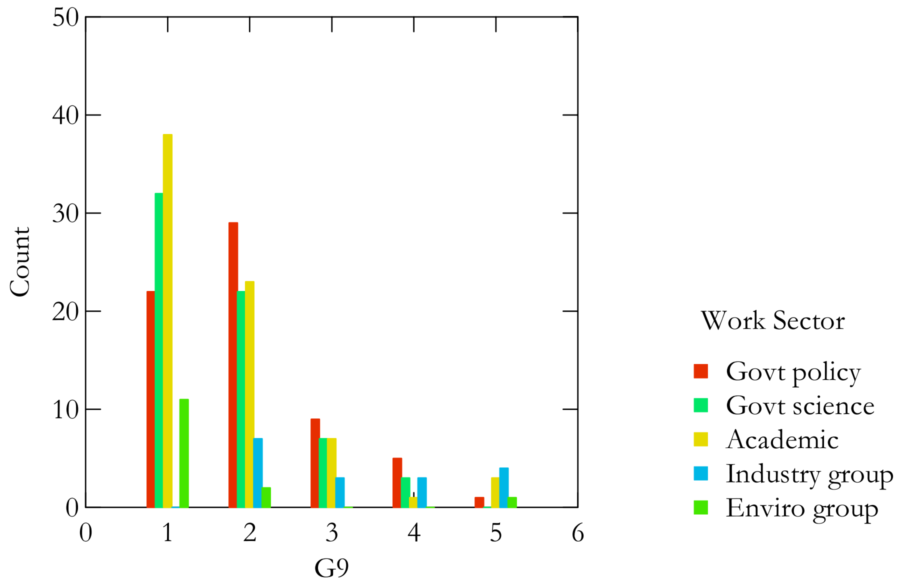
	1	2	3	4	5	Total
Frequency	*68*	**75**	27	46	17	233
Percentage	29.185	32.189	11.588	19.742	7.296	100

f. Scientists do not understand the policy process.



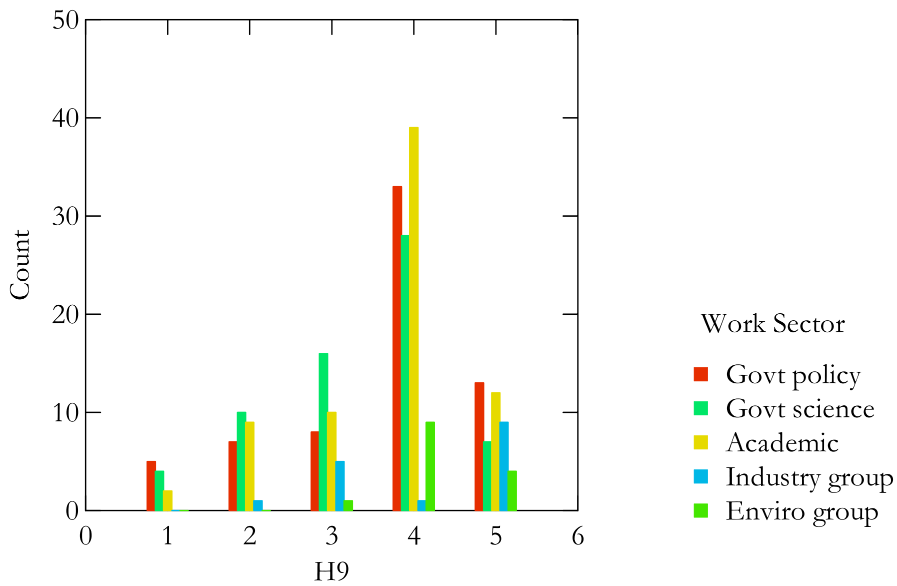
	1	2	3	4	5	Total
Frequency	22	**78**	*54*	53	27	234
Percentage	9.402	33.333	23.077	22.650	11.538	100

g. Protecting marine ecosystems should be the priority for policy.



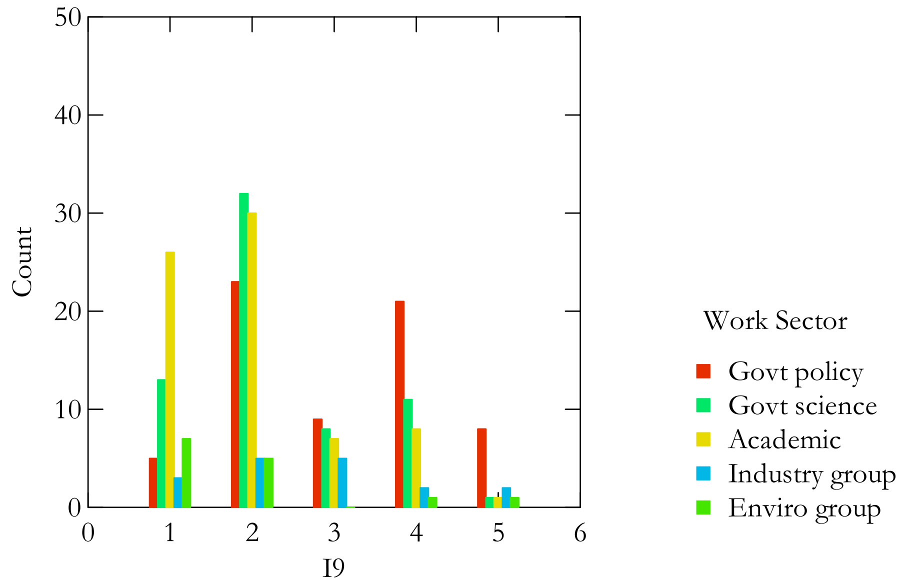
	1	2	3	4	5	Total
Frequency	**103**	*83*	26	12	9	233
Percentage	44.206	35.622	11.159	5.150	3.863	100

h. Scientific advice is always independent of policy purposes.



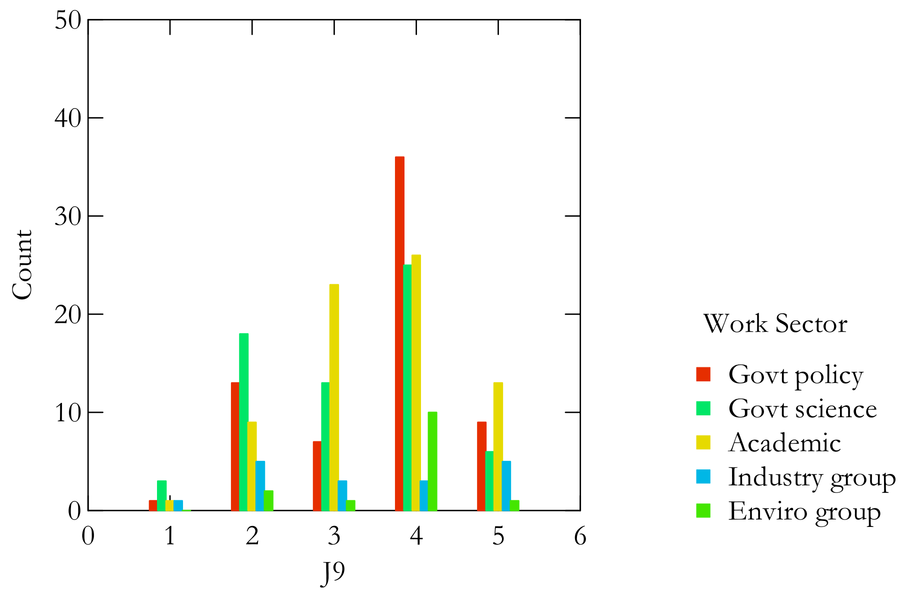
	1	2	3	4	5	Total
Frequency	11	27	40	**110**	*45*	233
Percentage	4.721	11.588	17.167	47.210	19.313	100

i. Policymakers frequently discount scientific advice.



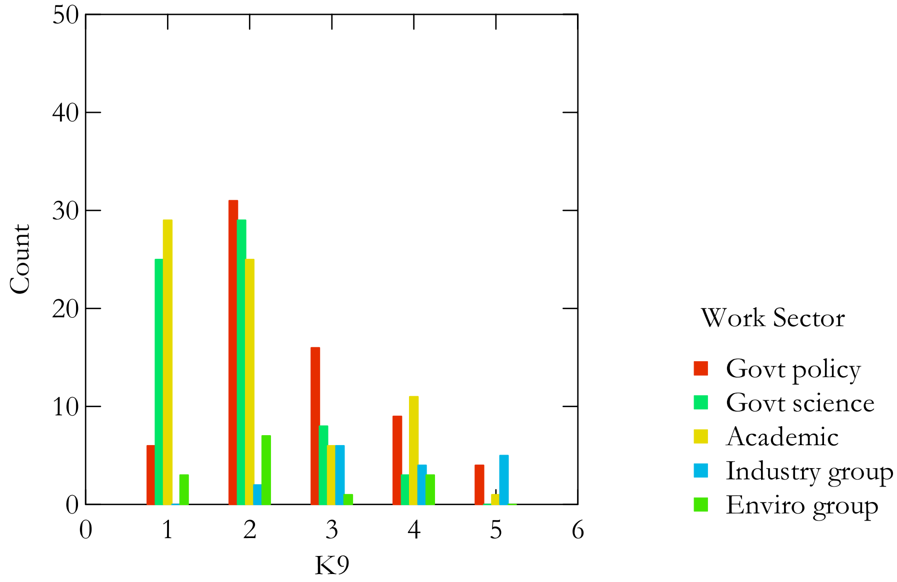
	1	2	3	4	5	Total
Frequency	54	**95**	29	*43*	13	234
Percentage	23.077	40.598	13.393	18.376	5.556	100

j. Scientific advice is well communicated to policymakers.



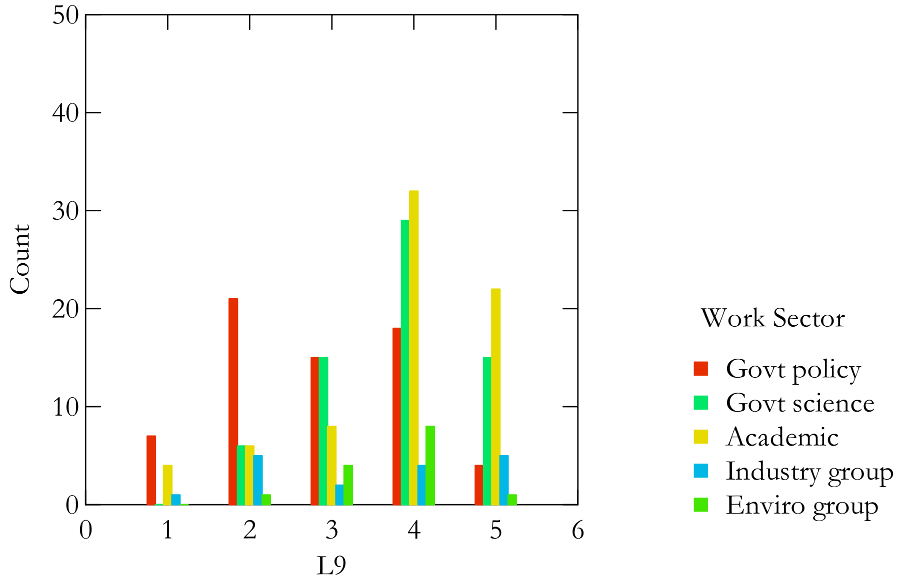
	1	2	3	4	5	Total
Frequency	6	*47*	*47*	**100**	34	234
Percentage	2.564	20.085	20.085	42.735	14.530	100

k. Science should shape marine policy.



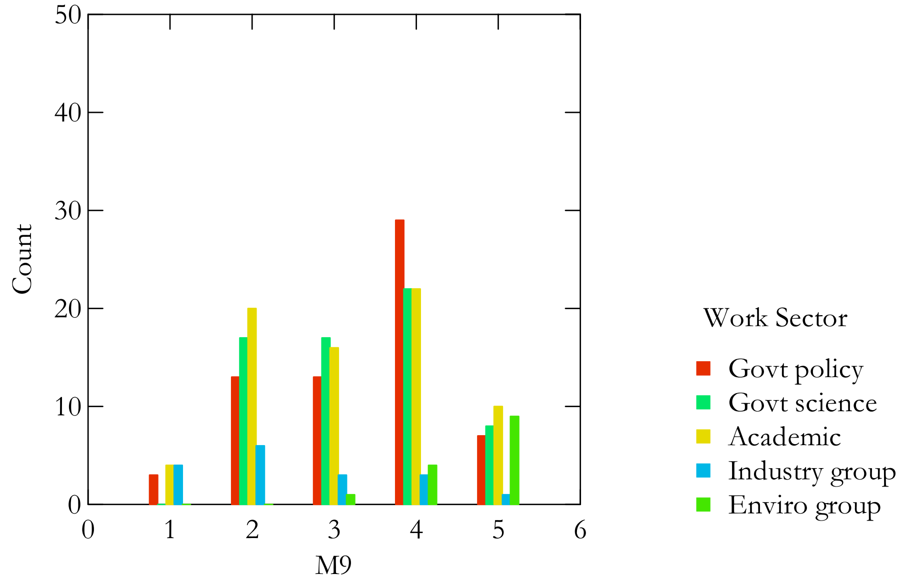
	1	2	3	4	5	Total
Frequency	*63*	**94**	37	30	10	234
Percentage	26.923	40.171	15.812	12.821	4.274	100

l. Policymakers understand scientific information.



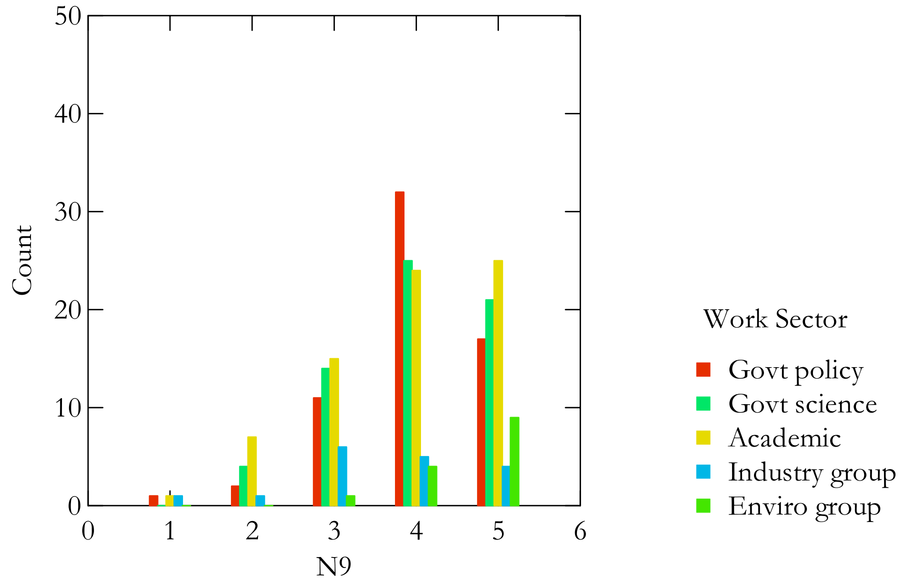
	1	2	3	4	5	Total
Frequency	12	39	44	**91**	*47*	233
Percentage	5.150	16.738	18.884	39.056	20.172	100

m. Scientific advice is biased towards conservation.



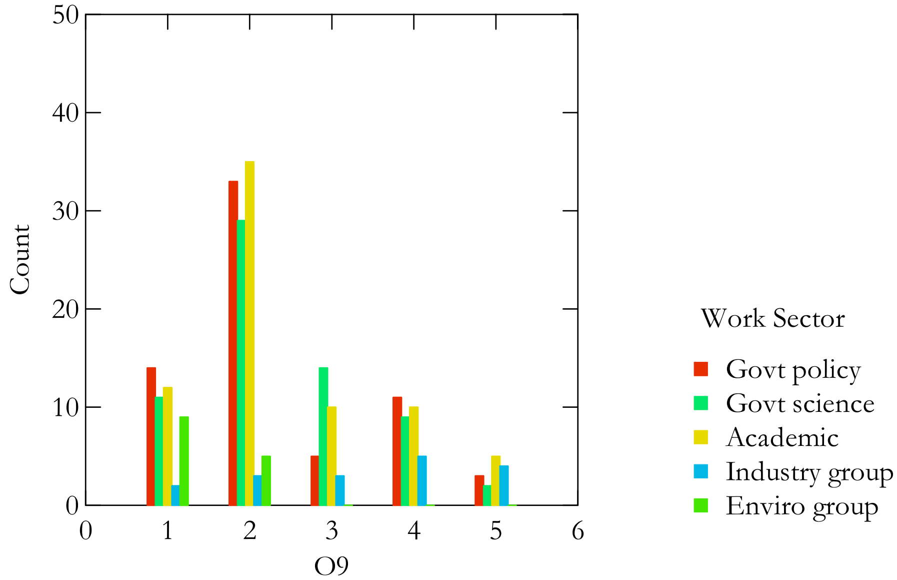
	1	2	3	4	5	Total
Frequency	11	*56*	50	**80**	35	232
Percentage	4.741	24.138	21.552	34.483	15.086	100

n. Marine policy should prioritise employment.



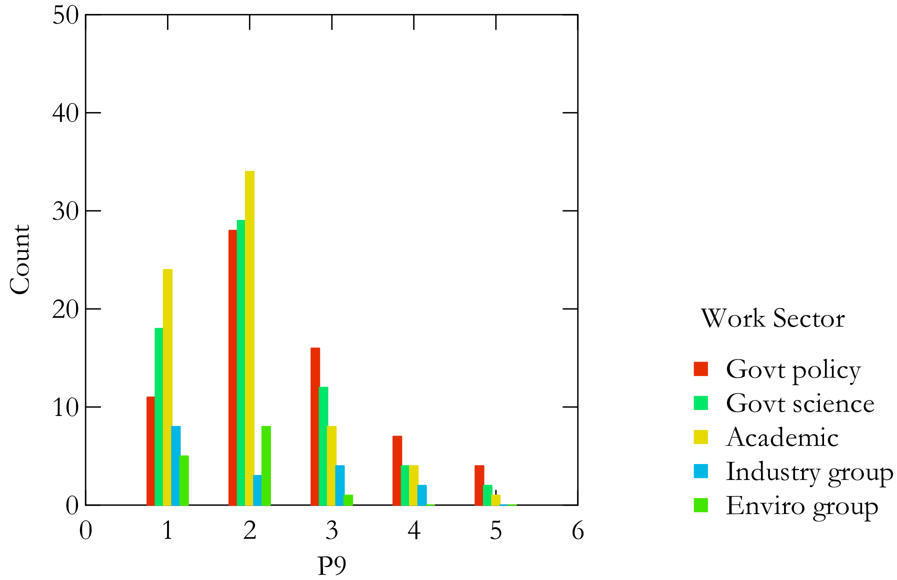
	1	2	3	4	5	Total
Frequency	3	14	47	**90**	*76*	230
Percentage	1.304	6.087	20.435	39.130	33.043	100

o. The needs of the fishing industry dominate fisheries policy.



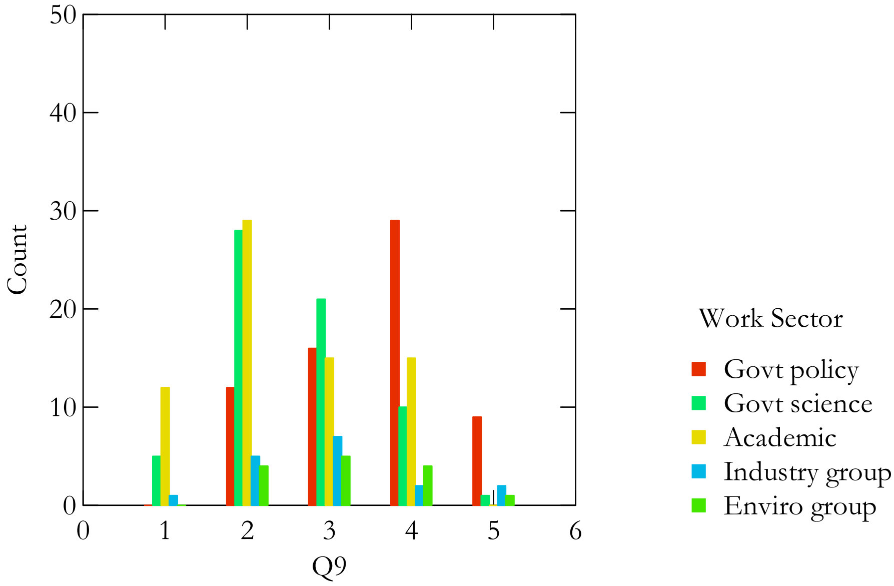
	1	2	3	4	5	Total
Frequency	*48*	**105**	32	35	14	234
Percentage	20.513	44.872	13.675	14.957	5.983	100

p. Scientific research results are selectively interpreted for political use.



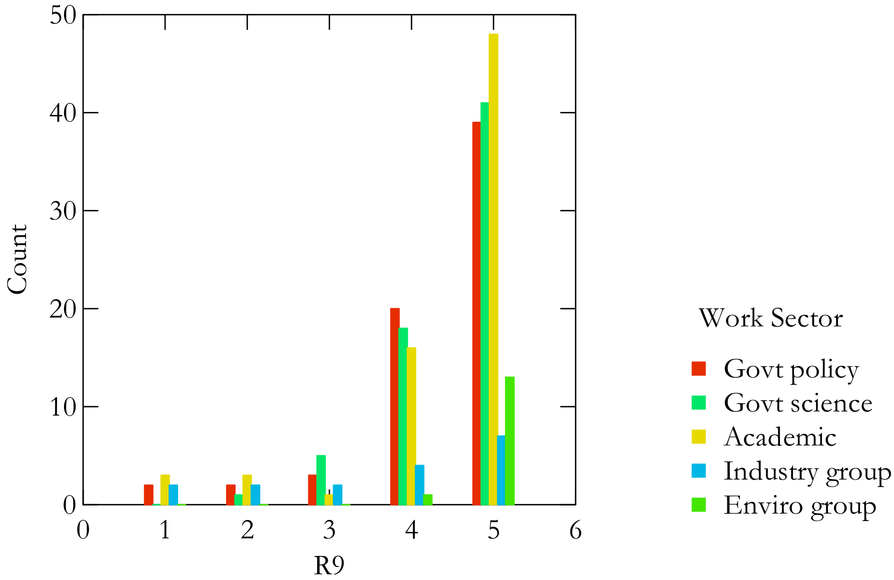
	1	2	3	4	5	Total
Frequency	*66*	**102**	41	17	7	233
Percentage	28.326	43.777	17.597	7.296	3.004	100

q. Policymakers have little understanding of scientific advice.



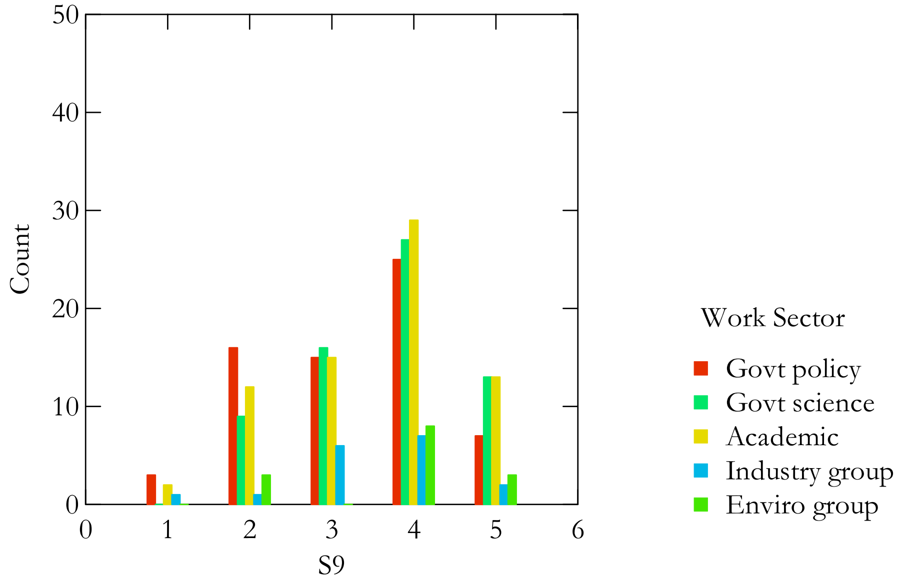
	1	2	3	4	5	Total
Frequency	18	**78**	*64*	60	13	233
Percentage	7.725	33.476	27.468	25.571	5.579	100

r. Fisheries should be managed to maximise catch.



	1	2	3	4	5	Total
Frequency	7	8	11	*59*	**148**	233
Percentage	3.004	3.433	4.721	25.322	63.519	100

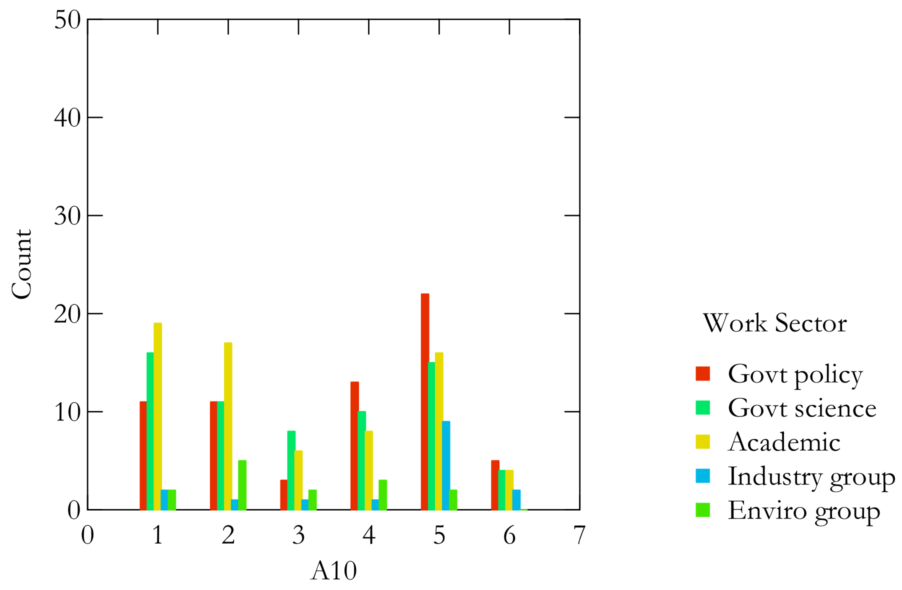
s. Scientific advice is too vague for good decision-making.



	1	2	3	4	5	Total
Frequency	6	41	*52*	**96**	38	233
Percentage	2.575	17.597	22.318	41.202	16.309	100

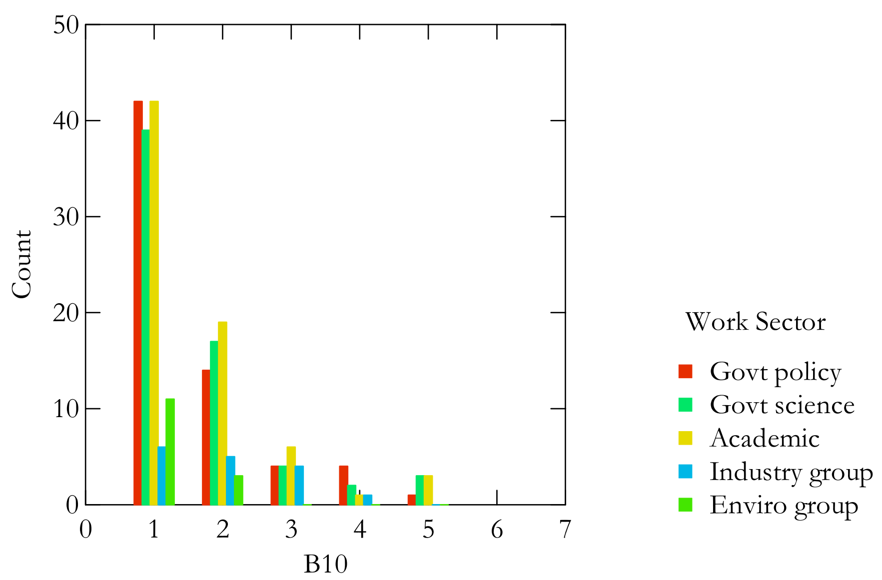
10. Please number the following in the order of how important you see these values are in managing the oceans (1 = most important, 6 = least important):

Intrinsic value



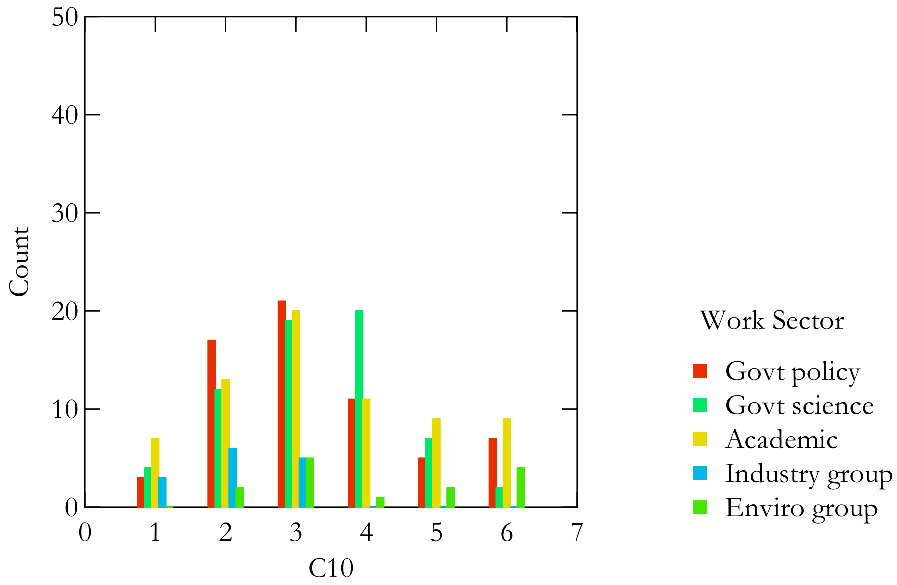
	1	2	3	4	5	6	Total
Frequency	*50*	45	20	35	**64**	15	229
Percentage	21.834	19.651	8.734	15.284	27.984	6.550	100

Biodiversity value



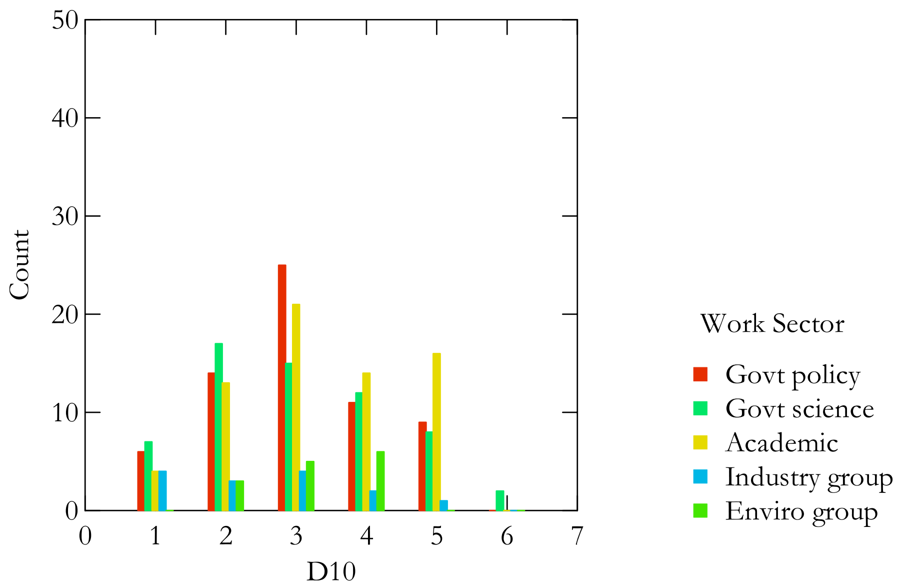
	1	2	3	4	5	6	Total
Frequency	**140**	*58*	18	8	7	0	231
Percentage	60.606	25.108	7.792	3.463	3.030	0	100

Economic value



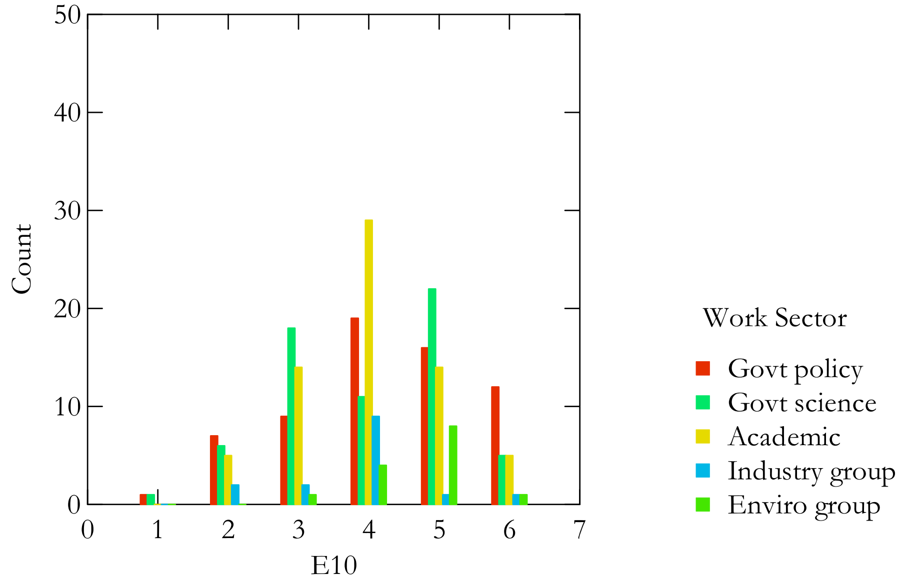
	1	2	3	4	5	6	Total
Frequency	17	*50*	**70**	43	23	22	225
Percentage	7.556	22.222	31.111	19.111	10.222	9.778	100

Social value



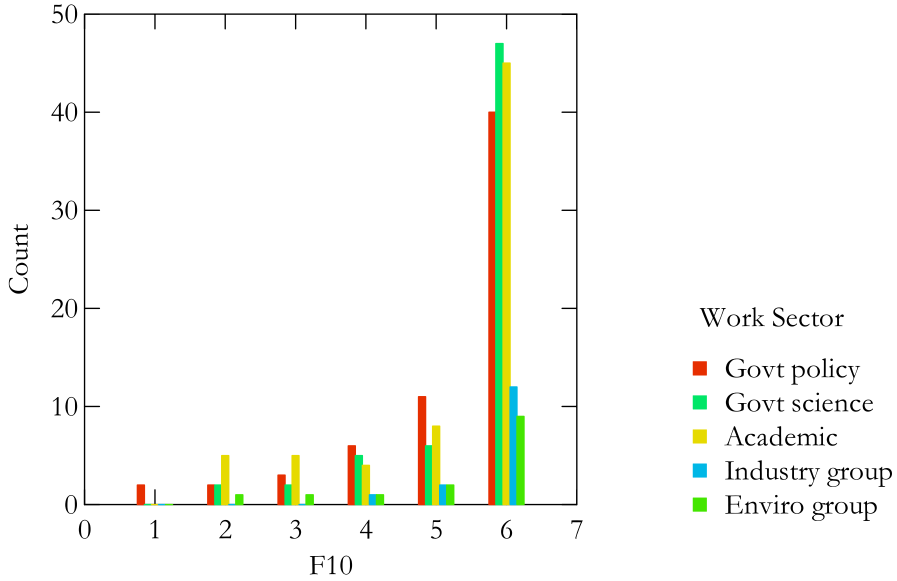
	1	2	3	4	5	6	Total
Frequency	21	*50*	**70**	45	34	2	222
Percentage	9.459	22.523	31.532	20.270	15.315	0.901	100

Scientific value



	1	2	3	4	5	6	Total
Frequency	2	20	44	**72**	*61*	24	223
Percentage	0.897	8.969	19.731	32.287	27.354	10.762	100

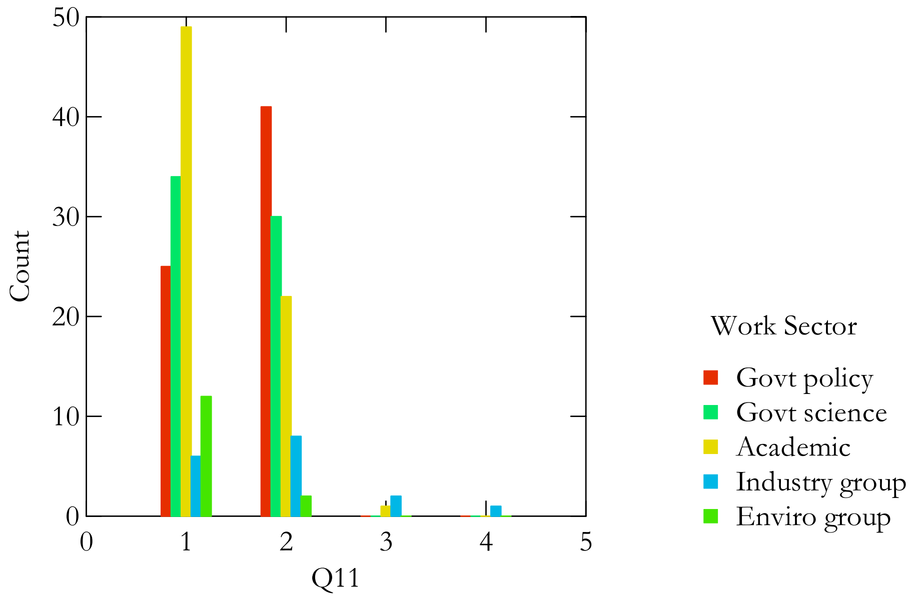
Spiritual value



	1	2	3	4	5	6	Total
Frequency	2	10	11	17	*29*	**153**	222
Percentage	0.901	4.505	4.955	7.658	13.063	68.919	100

11. Do you think there is a gap between scientific advice that is given and the final policy decision?

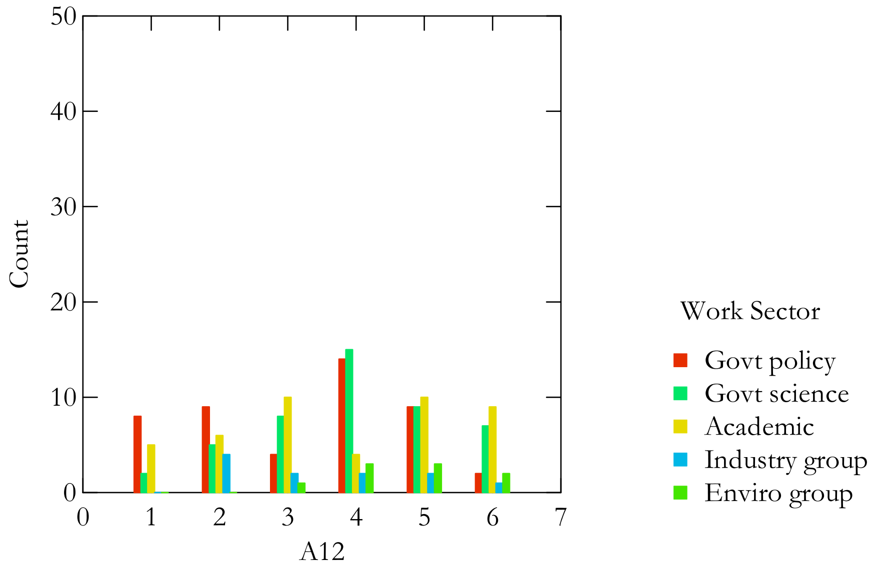
Often = 1   Sometimes = 2   Rarely = 3   Never = 4



	1	2	3	4	Total
Frequency	**126**	*103*	3	1	233
Percentage	54.077	44.026	1.288	0.429	100

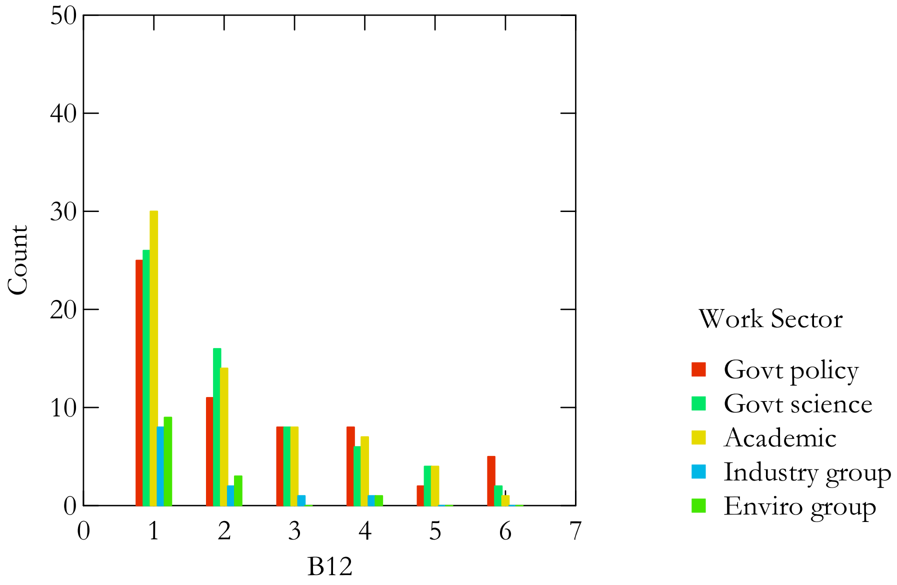
12. From the following terms, please choose six (6) that you consider to be the main reasons for the science–policy gap, ranking them: 1 = main reason; 6 = least reason.

Scientific uncertainty.



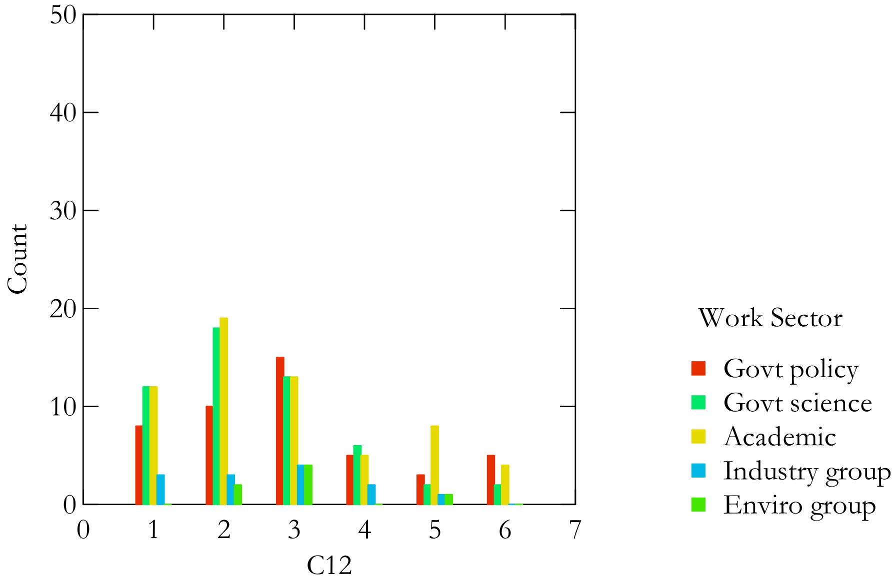
	1	2	3	4	5	6	Total
Frequency	15	24	25	**38**	*33*	21	156
Percentage	9.615	15.385	16.026	24.359	21.154	13.462	100

Political influences.



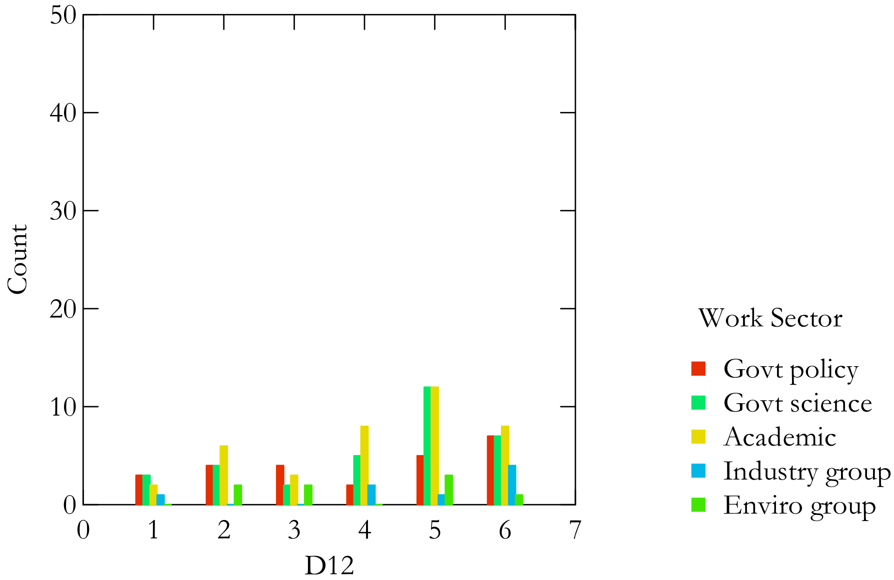
	1	2	3	4	5	6	Total
Frequency	**98**	*46*	25	23	10	8	210
Percentage	46.667	21.905	11.905	10.952	4.762	3.810	100

Short decision time-frames.



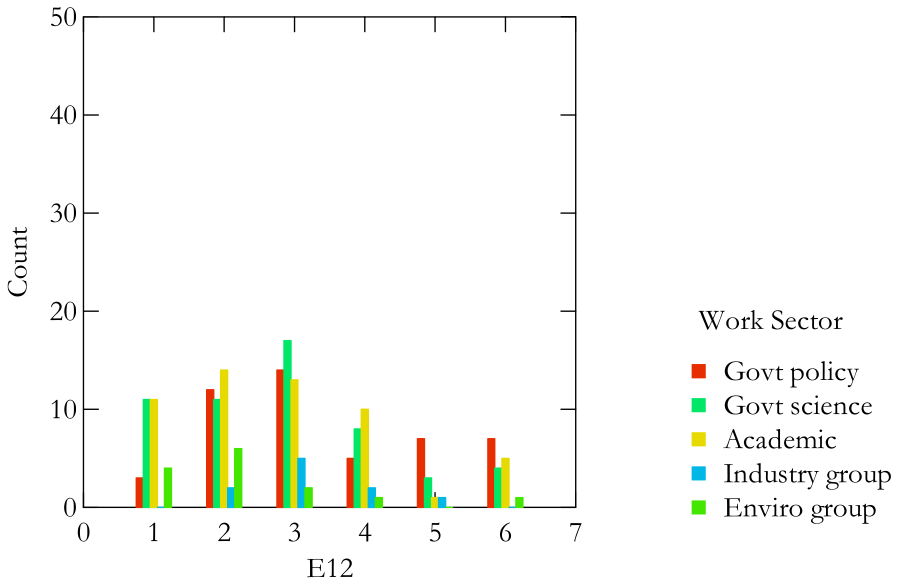
	1	2	3	4	5	6	Total
Frequency	35	**52**	*49*	18	15	11	180
Percentage	19.444	28.889	27.222	10	8.333	6.111	100

Communication of science.



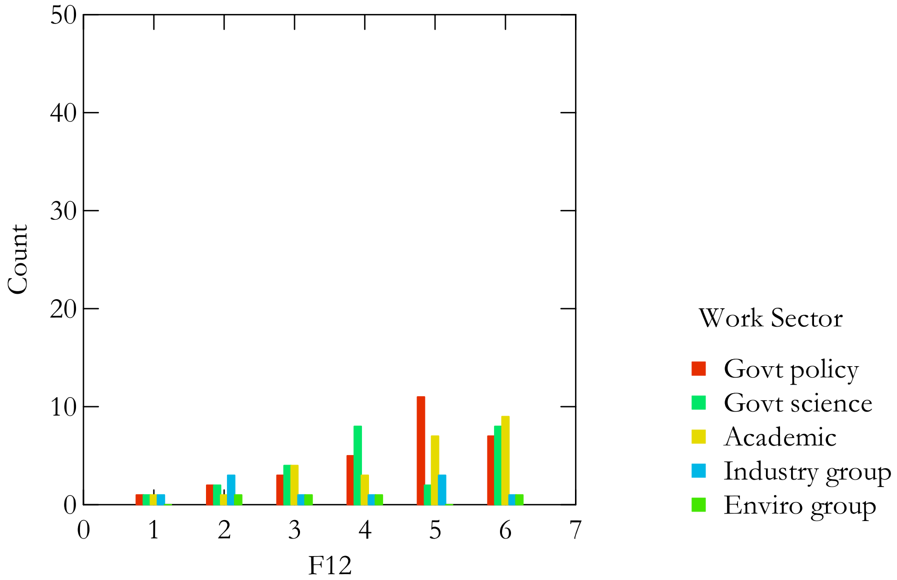
	1	2	3	4	5	6	Total
Frequency	9	16	11	17	**33**	*27*	113
Percentage	7.965	14.159	9.753	15.044	29.204	23.894	100

Commercial influences.



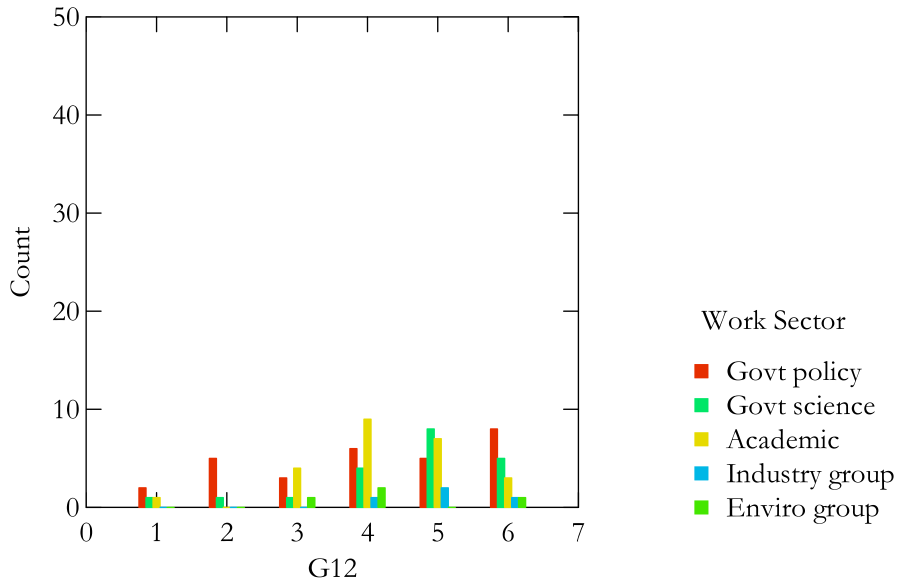
	1	2	3	4	5	6	Total
Frequency	29	*45*	**51**	26	12	17	180
Percentage	16.111	25	28.333	14.444	6.667	9.444	100

Inadequate, or poorly-framed, research questions.



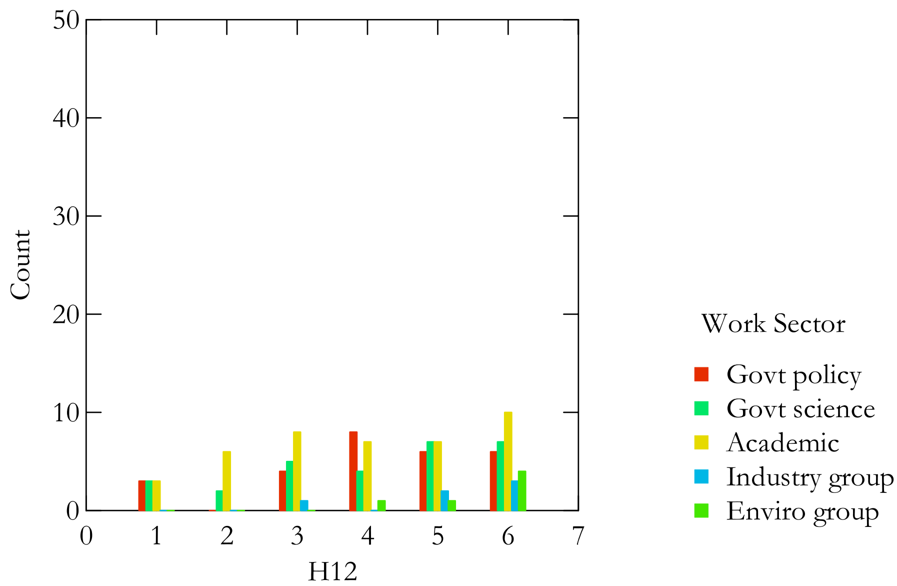
	1	2	3	4	5	6	Total
Frequency	4	9	13	18	*23*	**26**	93
Percentage	4.301	9.677	13.978	19.355	24.731	27.957	100

Cross-disciplinary communication.



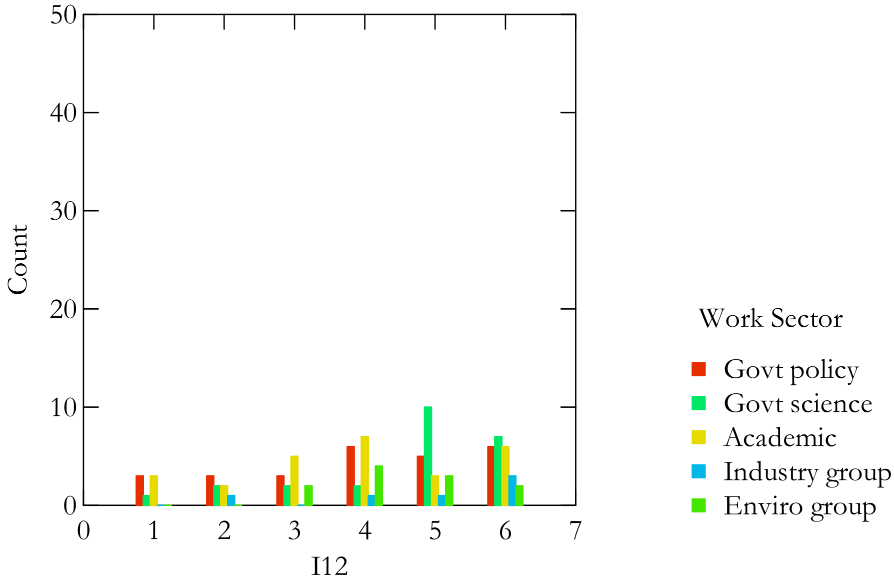
	1	2	3	4	5	6	Total
Frequency	4	6	9	**22**	**22**	*18*	81
Percentage	4.938	7.407	11.111	27.160	27.160	22.222	100

Cultural differences between scientists and policymakers.



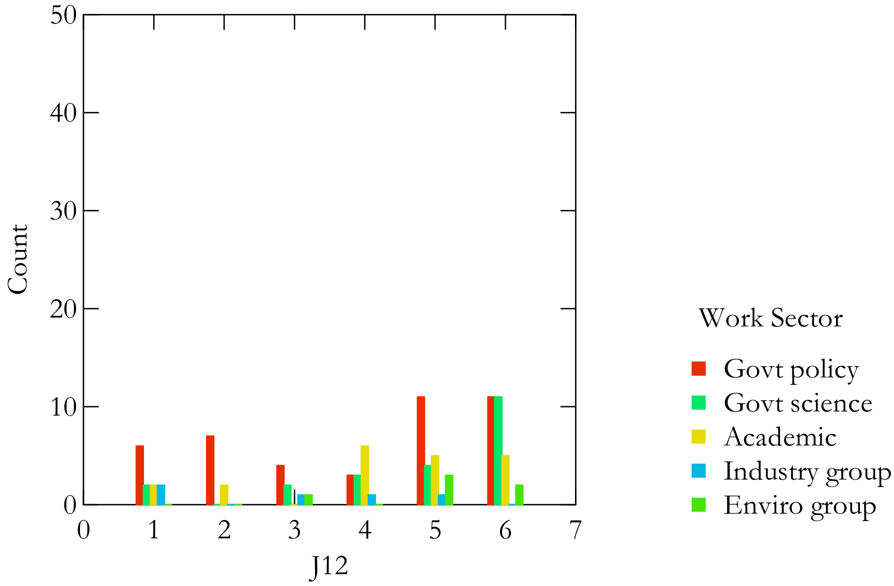
	1	2	3	4	5	6	Total
Frequency	9	8	18	20	*23*	**30**	108
Percentage	8.333	7.407	16.667	18.519	21.296	27.778	100

The use of science by management and policy institutions.



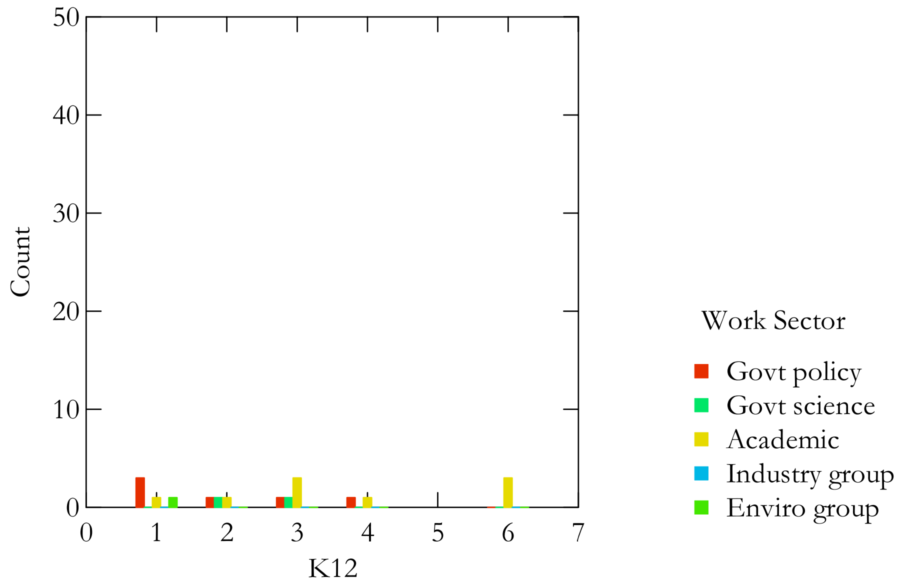
	1	2	3	4	5	6	Total
Frequency	7	8	12	20	*22*	**24**	91
Percentage	7.527	8.602	12.903	21.505	23.656	25.806	100

Relevancy of research to decisions.



	1	2	3	4	5	6	Total
Frequency	12	9	8	13	*24*	**29**	95
Percentage	12.632	9.474	8.421	13.684	25.263	30.526	100

Other

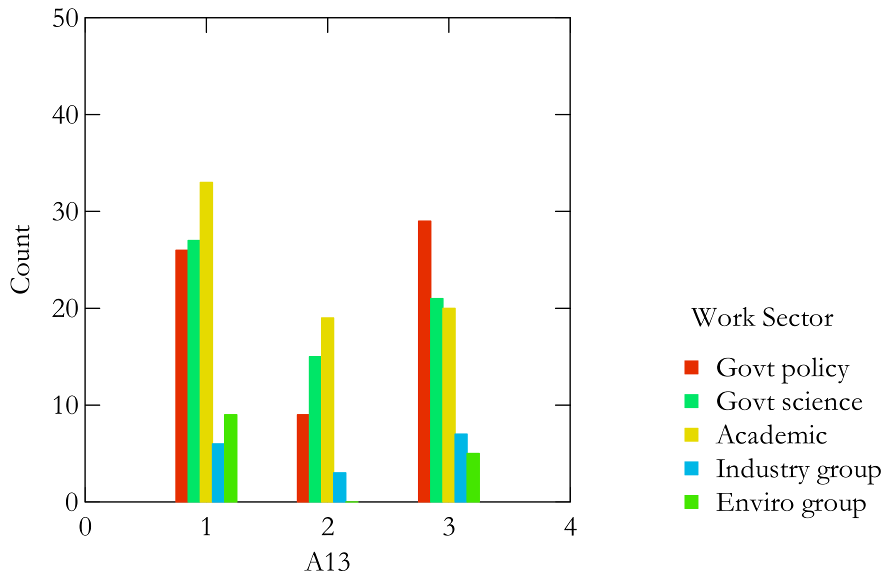


	1	2	3	4	5	6	Total
Frequency	**5**	*4*	**5**	2	0	3	19
Percentage	26.316	21.053	26.316	10.526	0	15.789	100

Respondent	Q. 12K 'Other'	Ranking	Sector
57	Balancing of need (ecology, economic, social).	1	Govt policy
64	This assumes that science is the primary driver of policy	1	Govt policy
107	Scientific advice not provided in a form that can be usefully applied in a policy/decision-making framework.	1	Enviro group
116	Government needs to make decisions based on values – policy questions are value questions and science can't always answer these questions.	1	Govt policy
162	Short-term objectives and goals (3-5 yrs) as opposed to biologically relevant scales (>20 yrs).	1	Academic
86	Policy's need to balance competing environmental, economic and social needs means that science alone cannot answer the question.	2	Govt policy
122	Slow provision of any answers by scientists; promising all and delivering little	2	Academic
125	Economic reasons	2	Govt science
4	Lobbying by "Greens" to return to pristine conditions to the detriment of commercial operations which are ecologically sustainable, provide the population with healthy and necessary food sources.	3	Industry work
23	Cultural importance of marine resources for people is often overlooked or not included	3	Academic
106	Lack of resources to do studies/research in the timeframe needed for management decisions.	3	Govt policy
170	There is often inertia amongst policy-makers and this prevents uptake of science	3	Academic
190	Financial constraints on research sometimes limit the effect of research (science), to policy-makers.	3	Academic
201	Biased, or narrow, terms of reference by politicians.	3	Govt science
49	Over-interpretation of data inconsistent with data sensitivity or robustness	4	Govt policy
193	Science is not the only area of knowledge for making decisions.	4	Academic
67	Poor targeting of research in relation to scales of space or time for decision or management contexts.	6	Academic
191	A politician is often like a guy working in a record shop = he does not know a lot about his work.	6	Academic
227	Triple bottom-line solutions are often needed – social and economic values also added to considerations of 'scientific' issues.	6	Academic

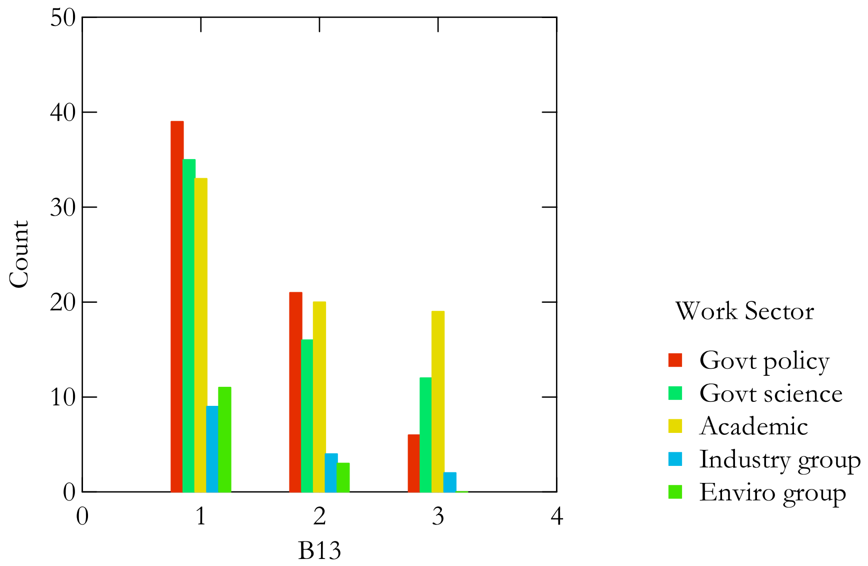
13. In making decisions about the management of natural marine resources, do the following factors create problems in making policy?

a. Does scientific reductionism create problems in making policy?



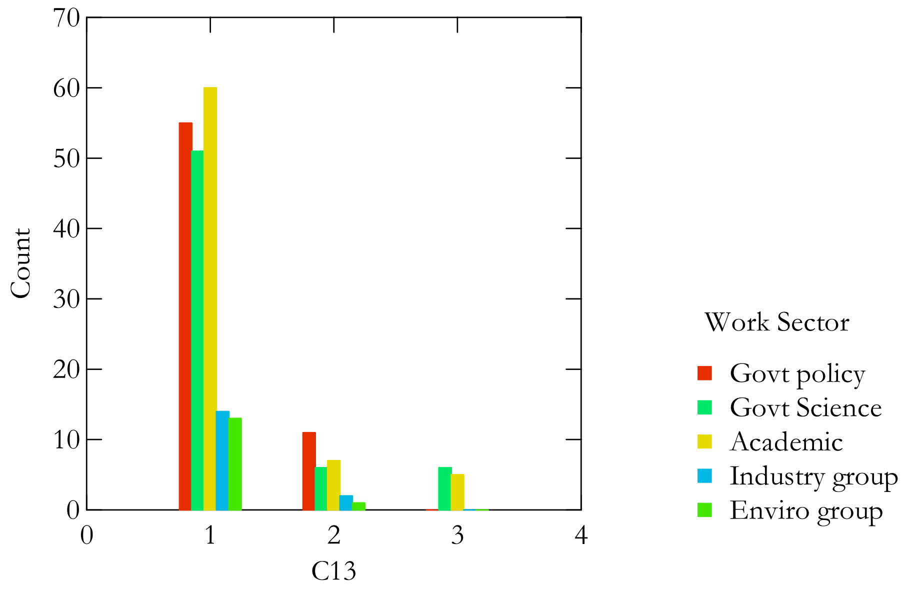
	1 = Yes	2 = No	3 = DK	Total
Frequency	**101**	46	*82*	239
Percentage	44.105	20.087	35.808	100

b. Do cause and effect relationships create problems in making policy?



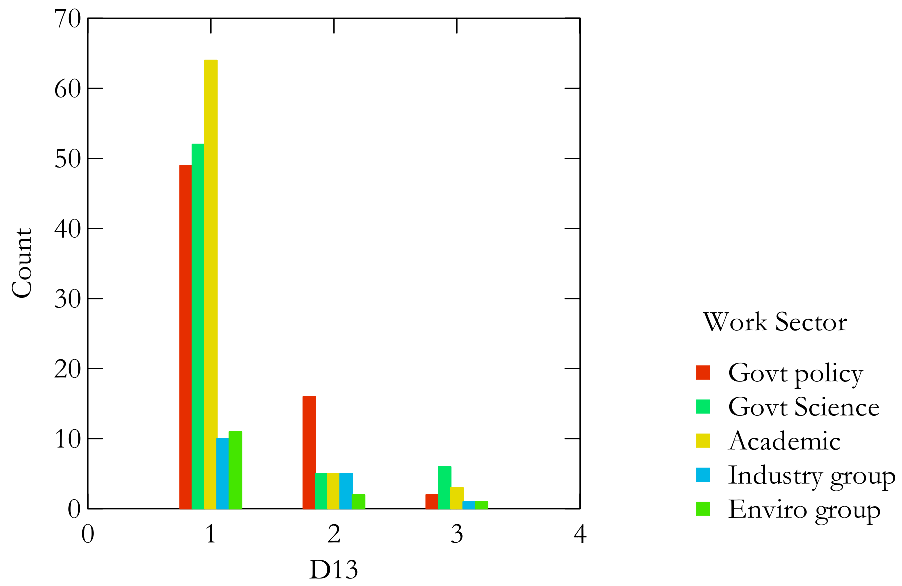
	1 = Yes	2 = No	3 = DK	Total
Frequency	**127**	*64*	39	230
Percentage	55.217	27.826	16.957	100

c. Does scientific uncertainty create problems in making policy?



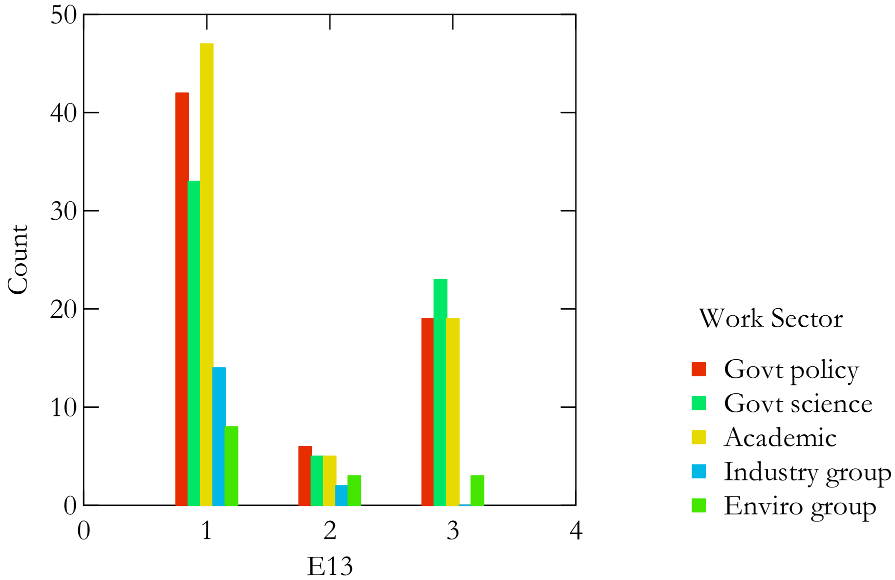
	1 = Yes	2 = No	3 = DK	Total
Frequency	**193**	*27*	11	231
Percentage	83.450	11.688	4.762	100

d. Does the market economy create problems in making policy?



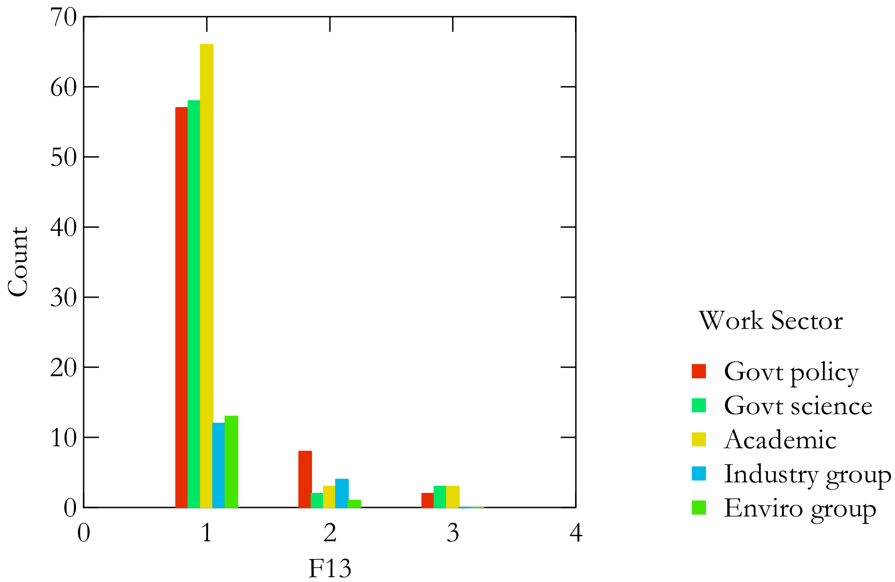
	1 = Yes	2 = No	3 = DK	Total
Frequency	**186**	*33*	13	232
Percentage	80.172	14.224	5.603	100

e. Does human–nature duality create problems in making policy?



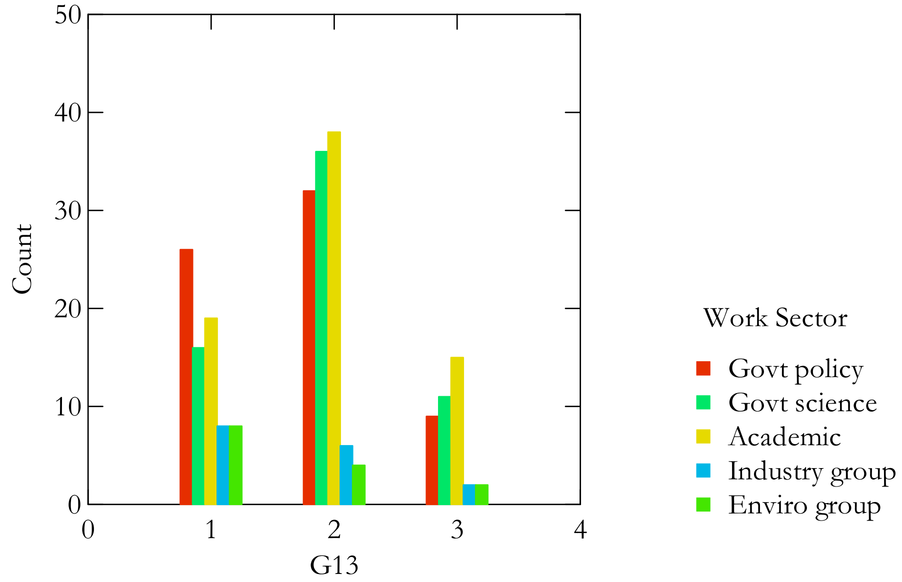
	1 = Yes	2 = No	3 = DK	Total
Frequency	**144**	21	*64*	229
Percentage	62.882	9.170	27.948	100

f. Do short-term policy goals create problems in making policy?



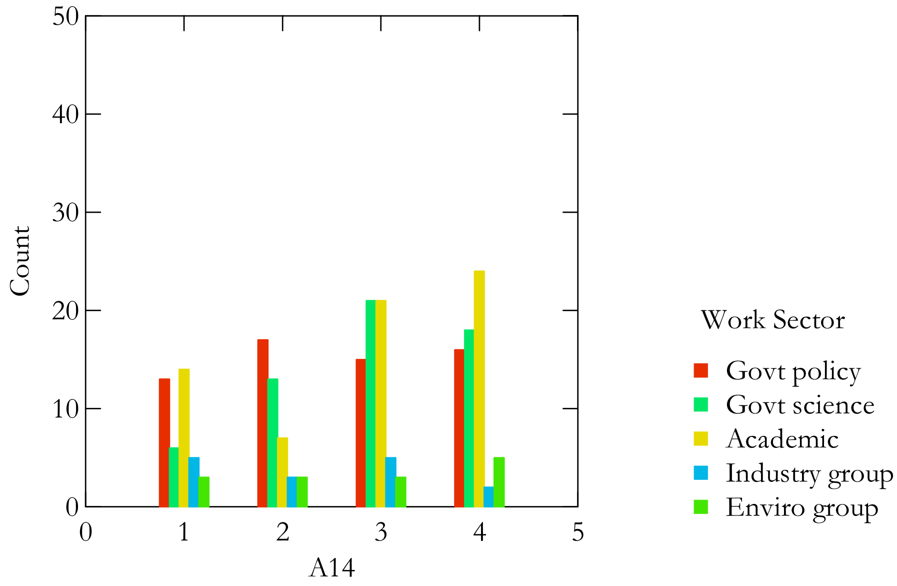
	1 = Yes	2 = No	3 = DK	Total
Frequency	**206**	*18*	8	232
Percentage	88.793	7.759	3.448	100

g. Does the scientific method create problems in making policy?



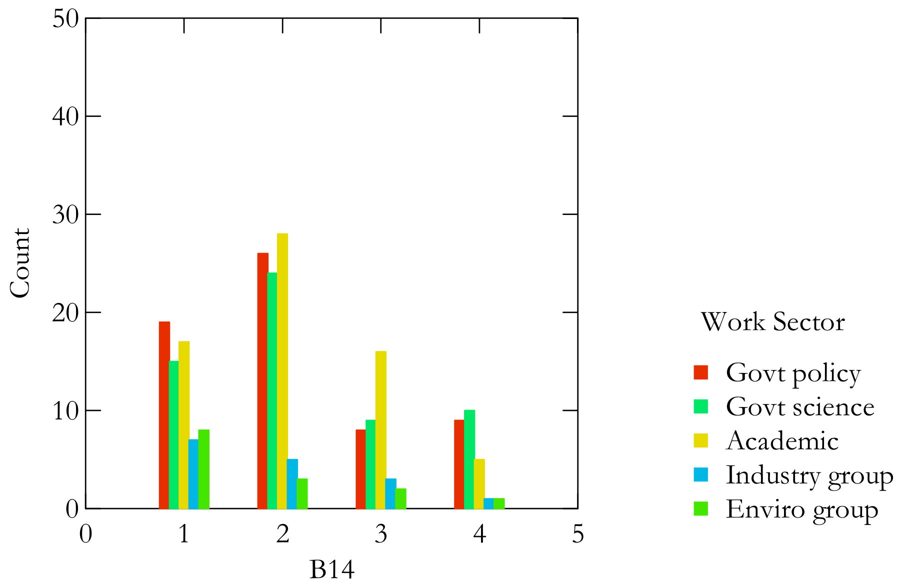
	1 = Yes	2 = No	3 = DK	Total
Frequency	*77*	**116**	39	232
Percentage	33.190	50	16.810	100

14. Below are four definitions of 'objective'. 1 = most agreement; 4 = least agreement.
Objective means public, publicly available, observable, or accessible (at least in principle).



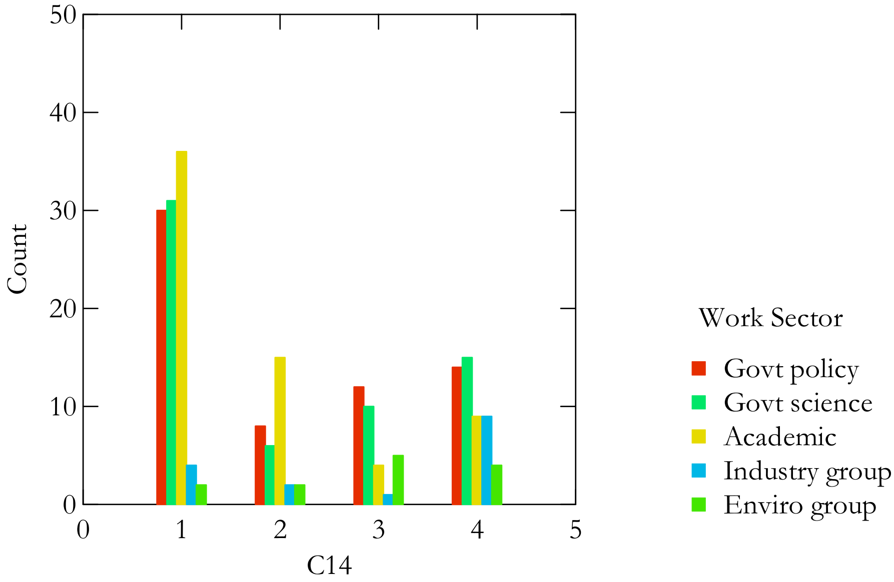
	1	2	3	4	Total
Frequency	41	*43*	**65**	**65**	214
Percentage	19.159	20.093	30.374	30.374	100

Objective means existing independently or seperately from us.



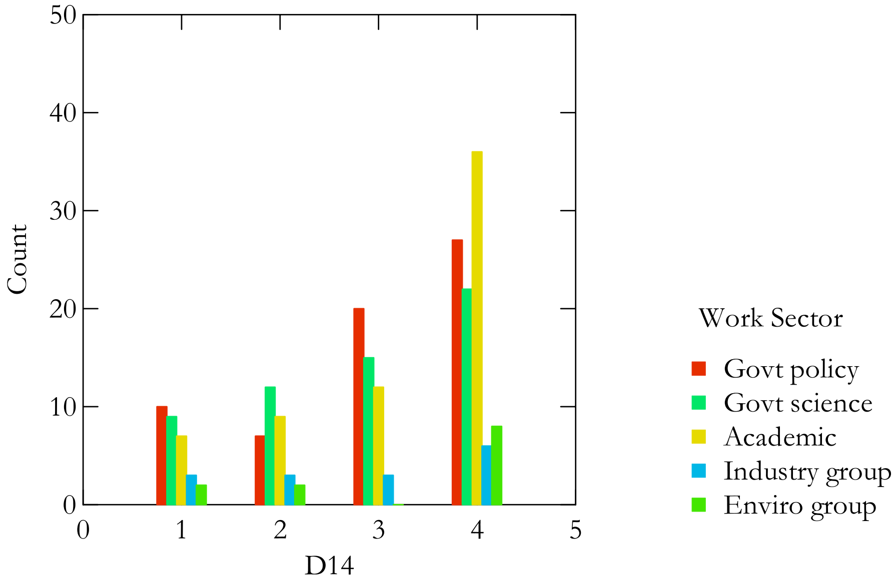
	1	2	3	4	Total
Frequency	*66*	**86**	38	26	216
Percentage	30.566	39.815	17.593	12.037	100

Objective means detached, disinterested, unbiased, impersonal, not having a point of view.



	1	2	3	4	Total
Frequency	**103**	33	32	*51*	219
Percentage	47.032	15.068	14.612	23.288	100

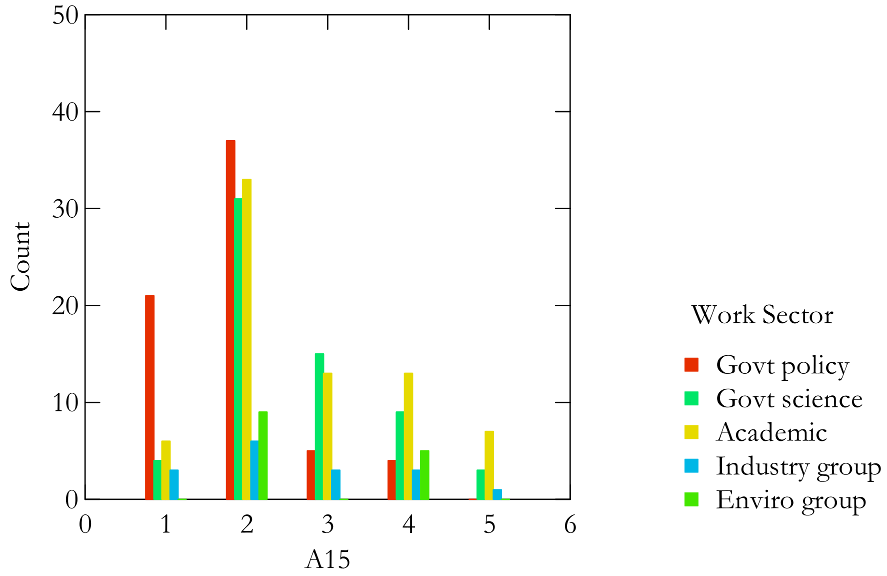
Objective means really existing, Really Real, the way things really are.



	1	2	3	4	Total
Frequency	31	33	*50*	**99**	213
Percentage	14.554	15.493	23.474	46.479	100

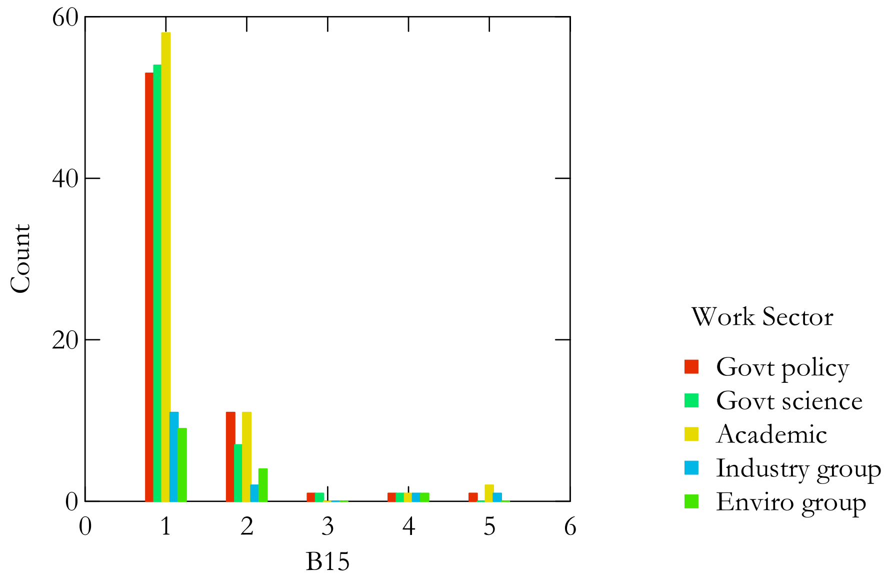
15. Please circle your level of agreement to the following statements; using this scale: 1–strongly agree; 2–moderately agree; 3–neutral; 4–moderately disagree; 5–strongly disagree.

a. Policymakers are receptive to research results.



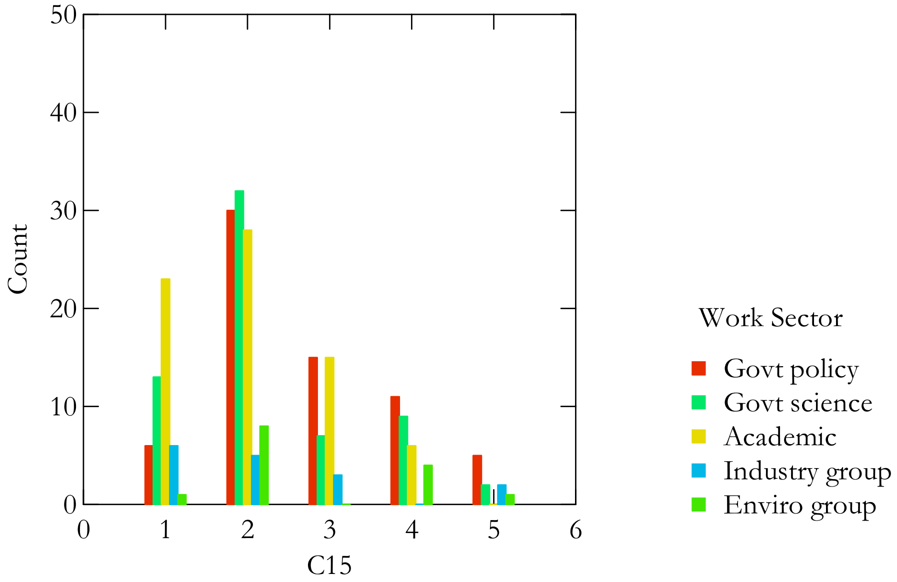
	1	2	3	4	5	Total
Frequency	34	**116**	*36*	34	11	231
Percentage	14.719	50.216	15.584	14.719	4.762	100

b. Scientists should strive to be objective and independent.



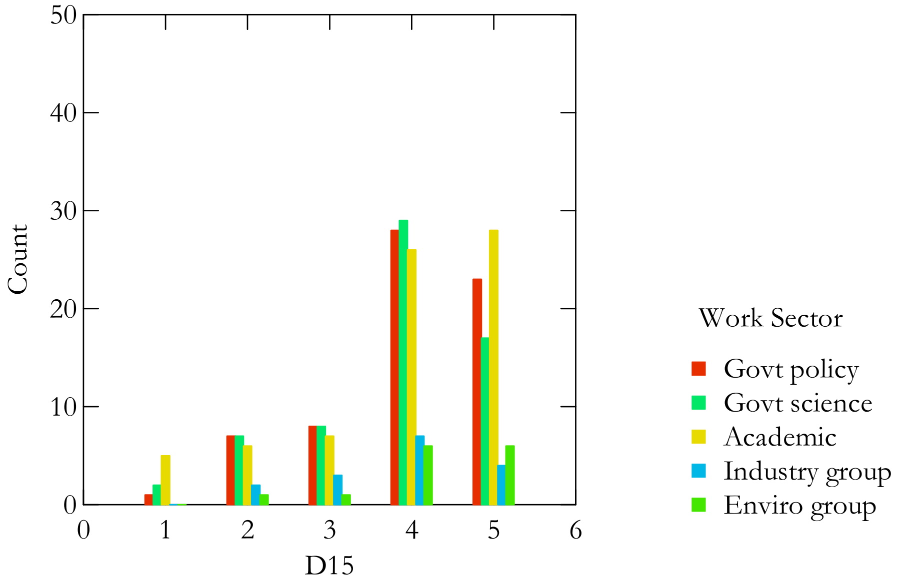
	1	2	3	4	5	Total
Frequency	**185**	*35*	2	5	4	231
Percentage	80.087	15.152	0.866	2.165	1.732	100

c. Policymakers select research that supports their policy goals.



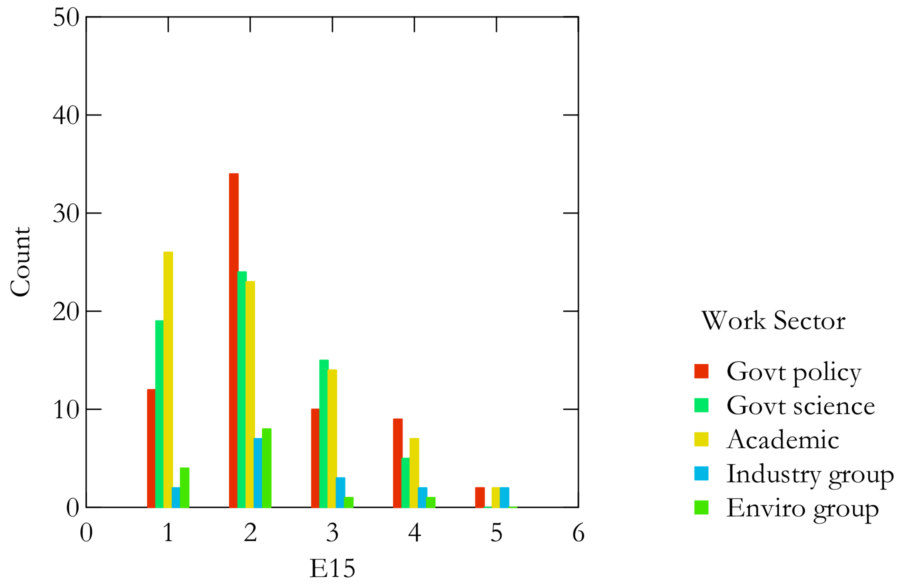
	1	2	3	4	5	Total
Frequency	49	**103**	40	30	10	232
Percentage	21.121	44.397	17.241	12.931	4.310	100

d. Research is funded to a level that gives clear answers to policy questions.



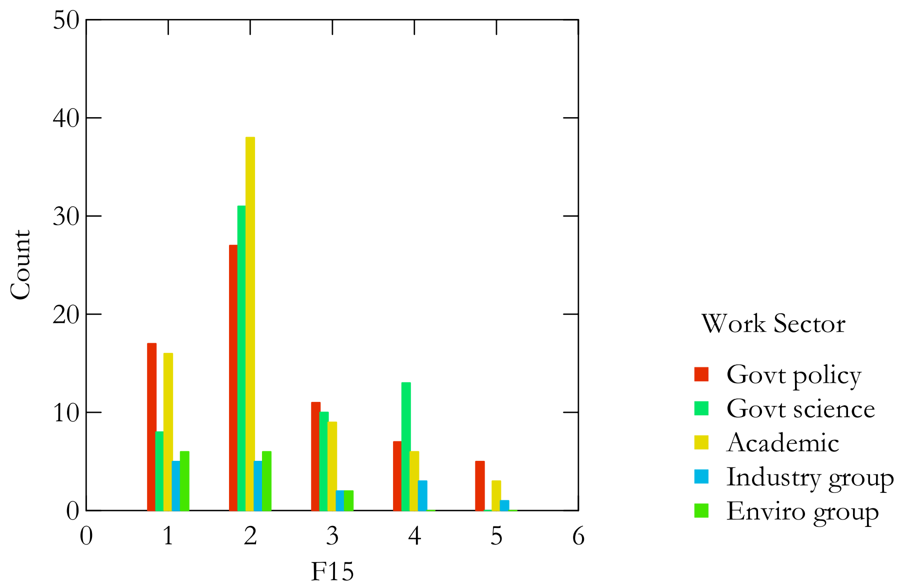
	1	2	3	4	5	Total
Frequency	8	23	27	**96**	*75*	232
Percentage	3.448	9.914	11.638	41.379	33.621	100

e. Policymaking and scientific research are based on different assumptions.



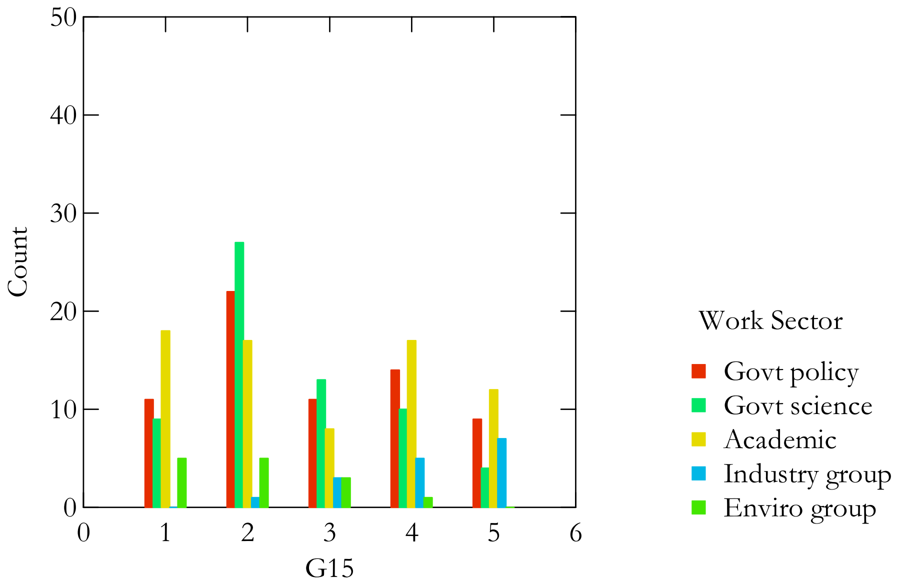
	1	2	3	4	5	Total
Frequency	*63*	**86**	43	24	6	232
Percentage	27.155	41.379	18.554	10.345	2.586	100

f. Scientific research is not independent of political institutions.



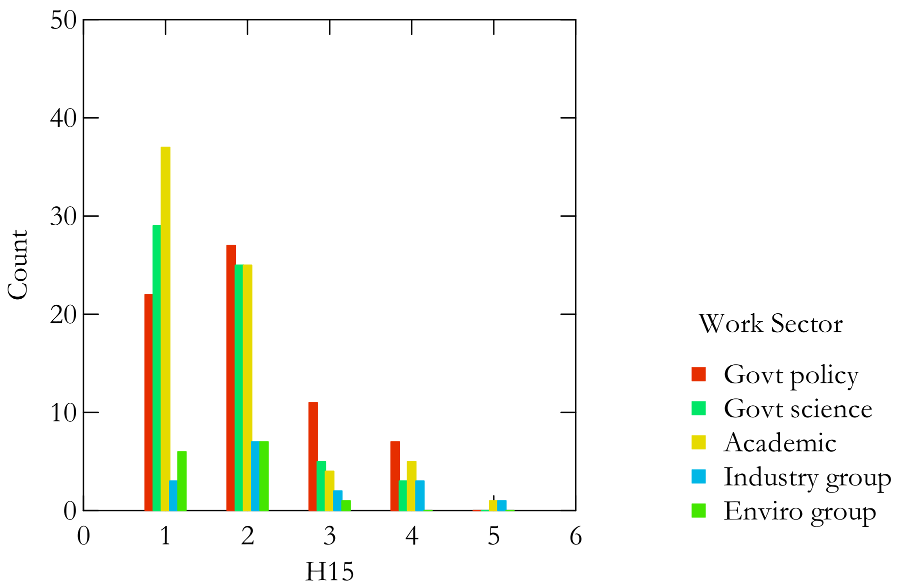
	1	2	3	4	5	Total
Frequency	52	**107**	34	29	9	231
Percentage	22.511	46.320	14.719	12.554	3.896	100

g. Scientists should advocate for policy outcomes.



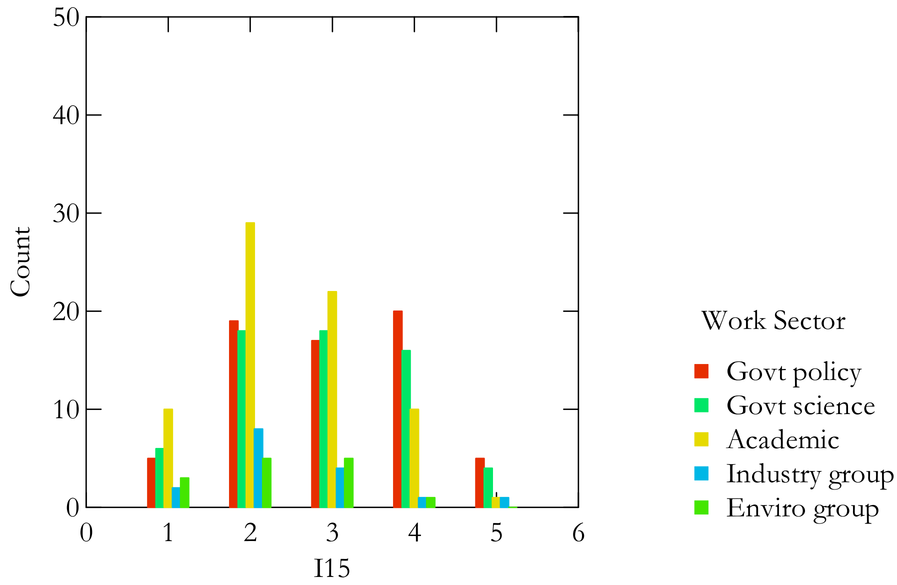
	1	2	3	4	5	Total
Frequency	43	**72**	38	*47*	32	232
Percentage	18.534	31.034	16.379	20.259	13.393	100

h. Policy should be science-based.



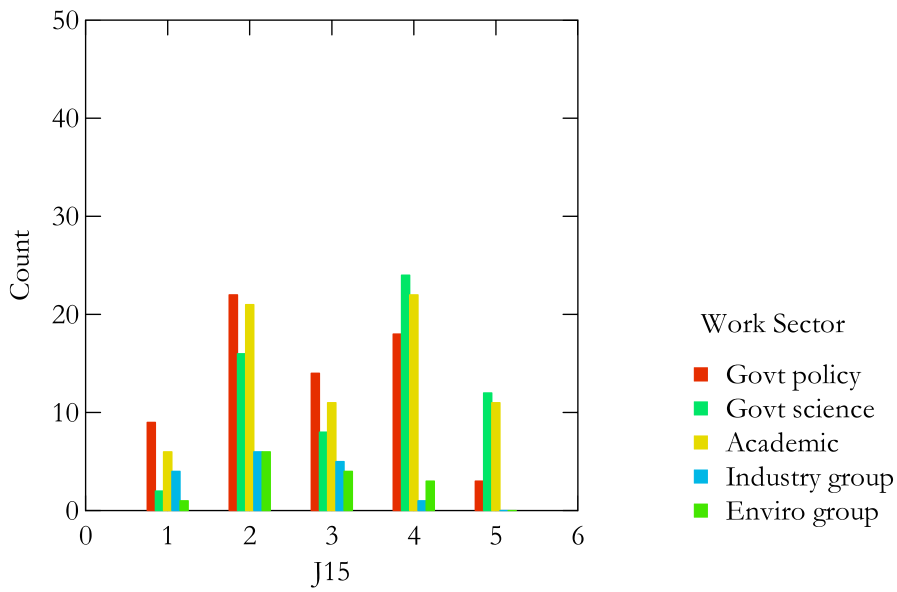
	1	2	3	4	5	Total
Frequency	**97**	*91*	23	18	2	231
Percentage	41.991	39.394	9.957	7.792	0.866	100

i. Research designed to answer a policy question is often politically biased.



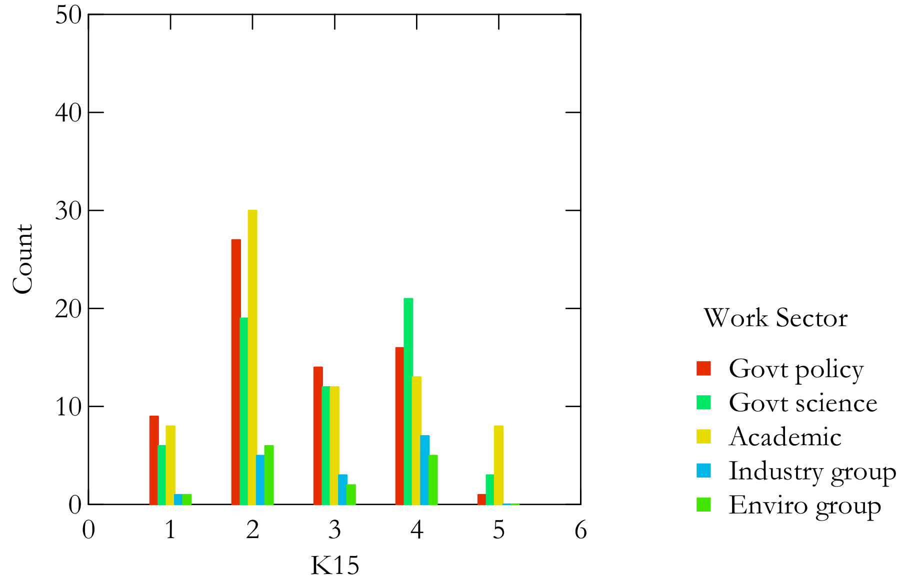
	1	2	3	4	5	Total
Frequency	26	**79**	*66*	48	11	230
Percentage	11.304	34.48	26.696	20.870	4.783	100

j. Scientific research culture makes it difficult to get clear answers.



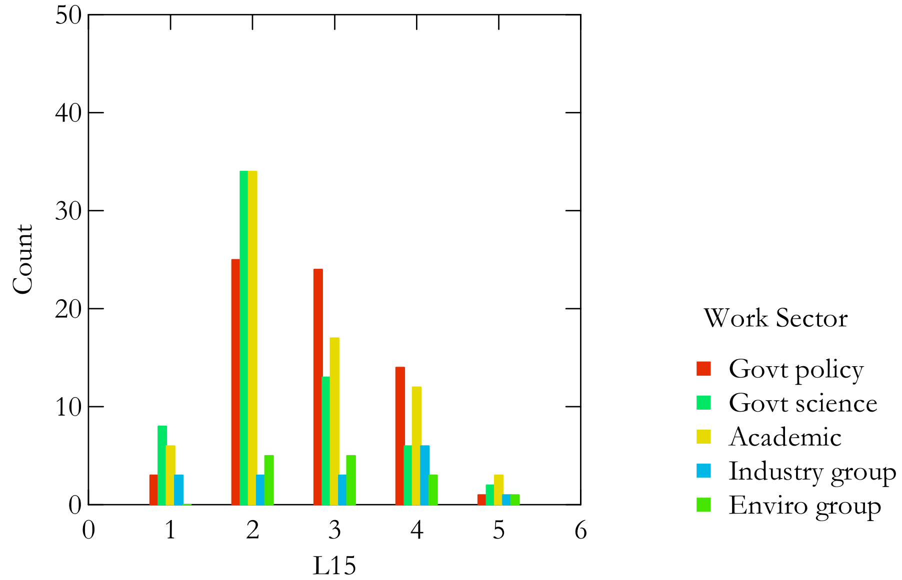
	1	2	3	4	5	Total
Frequency	22	**71**	42	*68*	26	229
Percentage	9.607	31.004	18.341	26.694	11.354	100

k. Science advice is not the most important factor in making policy decisions.



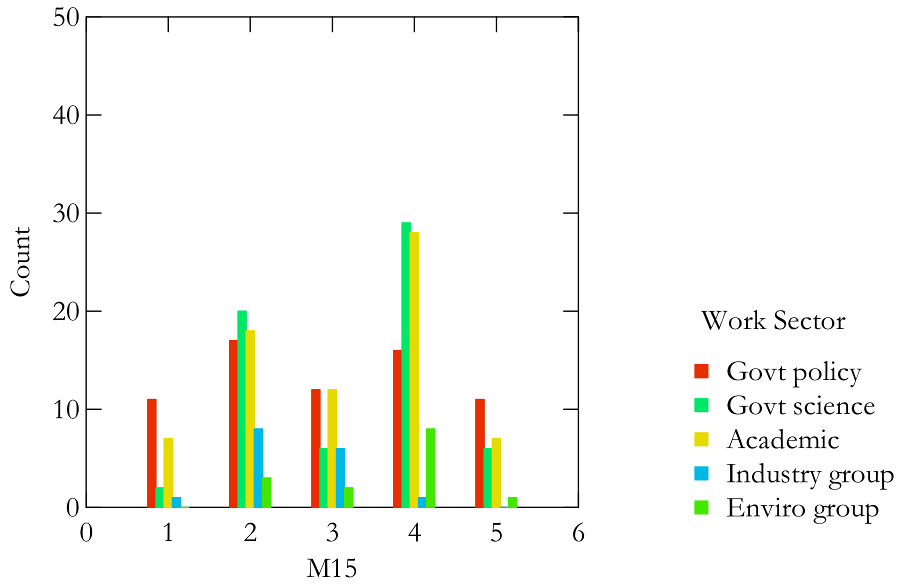
	1	2	3	4	5	Total
Frequency	25	**87**	43	*62*	12	229
Percentage	10.917	37.991	18.777	27.074	5.240	100

l. Scientists give objective, independent answers.



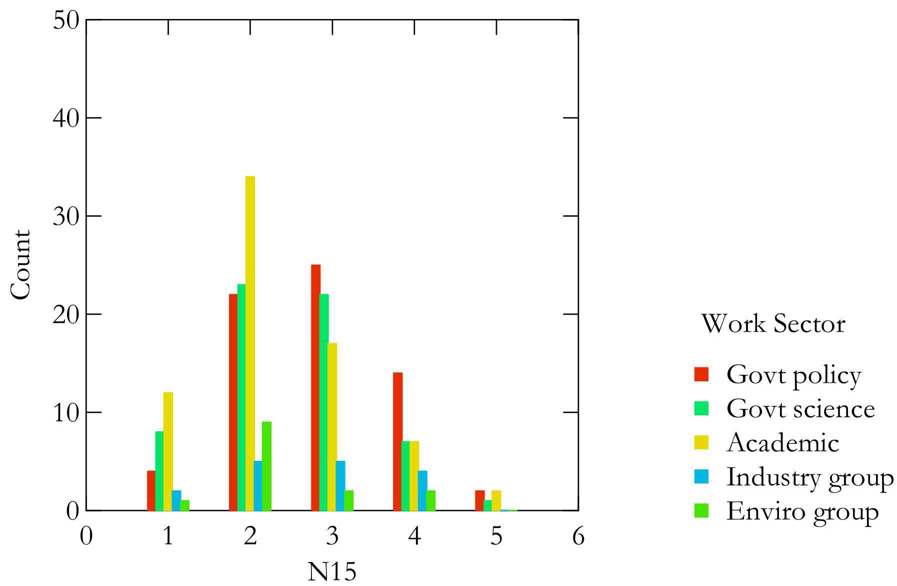
	1	2	3	4	5	Total
Frequency	20	**101**	*62*	41	8	232
Percentage	8.621	43.534	26.724	17.672	3.448	100

m. The major problem with science advice is lack of certainty.



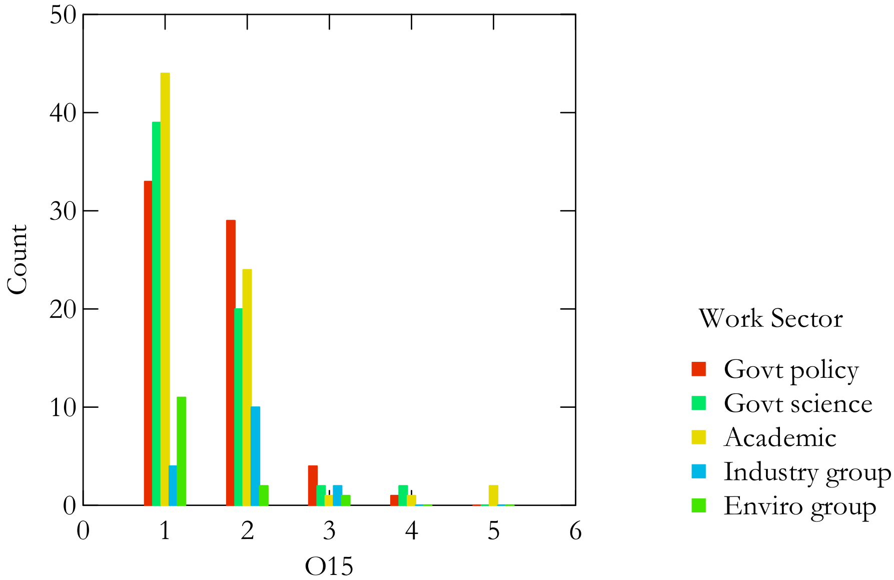
	1	2	3	4	5	Total
Frequency	21	*66*	38	**82**	25	232
Percentage	9.052	28.448	16.379	35.345	10.776	100

n. Research results are often not compatible with existing policy processes.



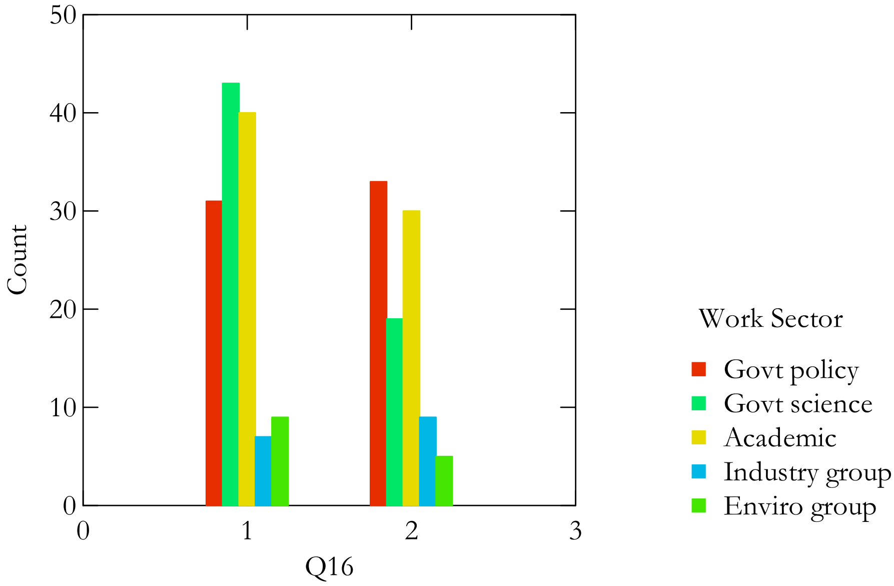
	1	2	3	4	5	Total
Frequency	27	**93**	*71*	34	5	230
Percentage	11.739	40.435	30.870	14.783	2.174	100

o. Policy should be advised by science



	1	2	3	4	5	Total
Frequency	**131**	*85*	10	4	2	232
Percentage	56.466	36.638	4.310	1.724	0.862	100

16. Do you agree with this statement made by Gro Harlem Brundtland:
'There is no other basis for sound political decisions than the best available scientific evidence.'



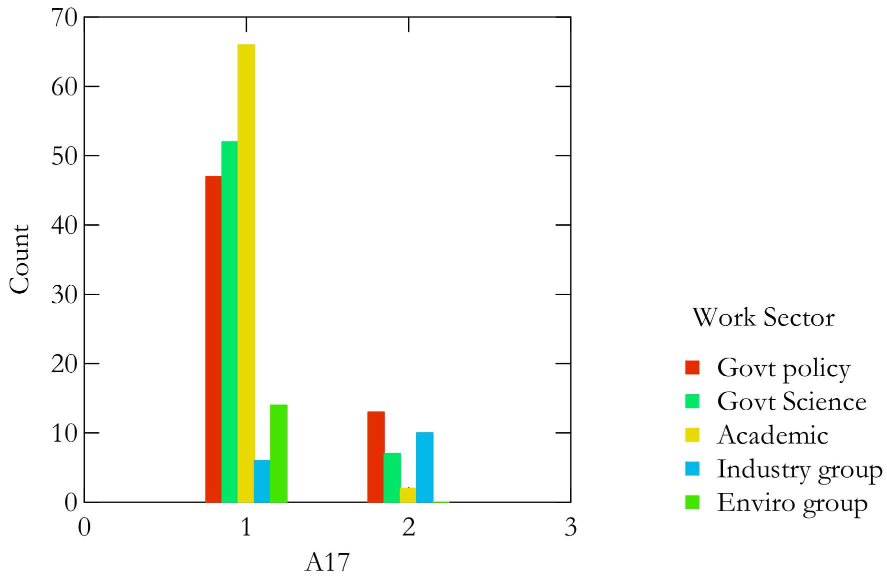
	1 = Yes	2 = No	Total
Frequency	130	96	226
Percentage	57.222	42.478	100

17. When are scientific research results likely to be ignored, dismissed, or marginalised?

YES = MOST likely to be ignored, dismissed or marginalised.

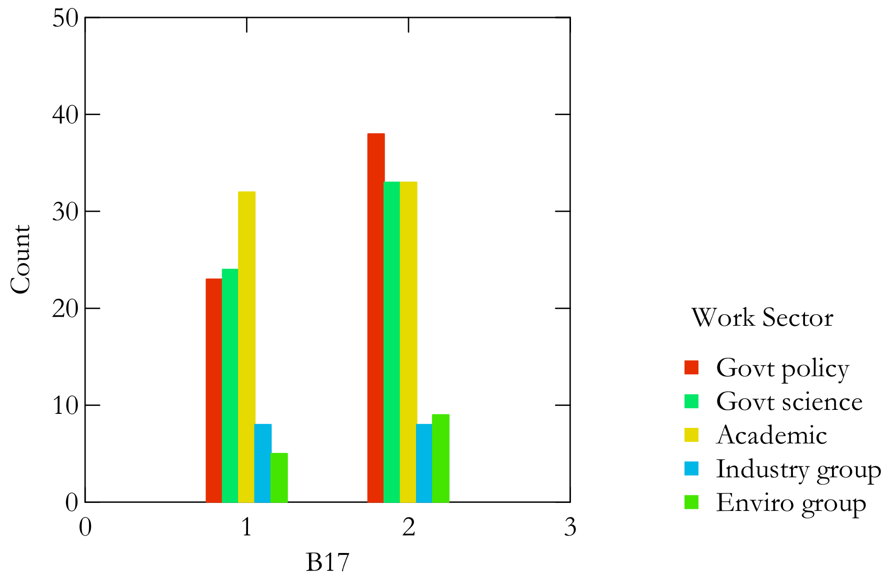
NO = LEAST likely to be ignored, dismissed or marginalised

If they do not support economic interests.



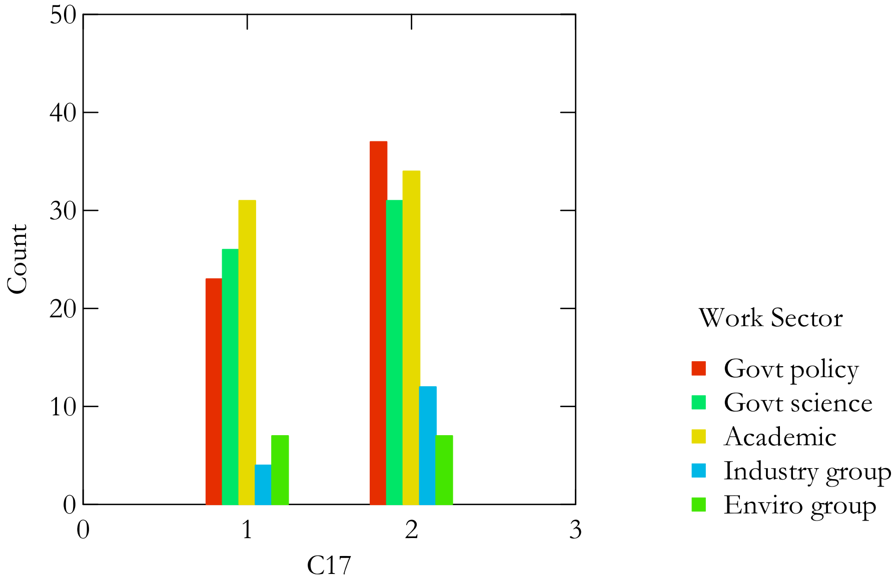
	1 = Yes	2 = No	Total
Frequency	185	32	217
Percentage	85.253	14.747	100

If they indicate an economic loss will occur if the results are not accepted.



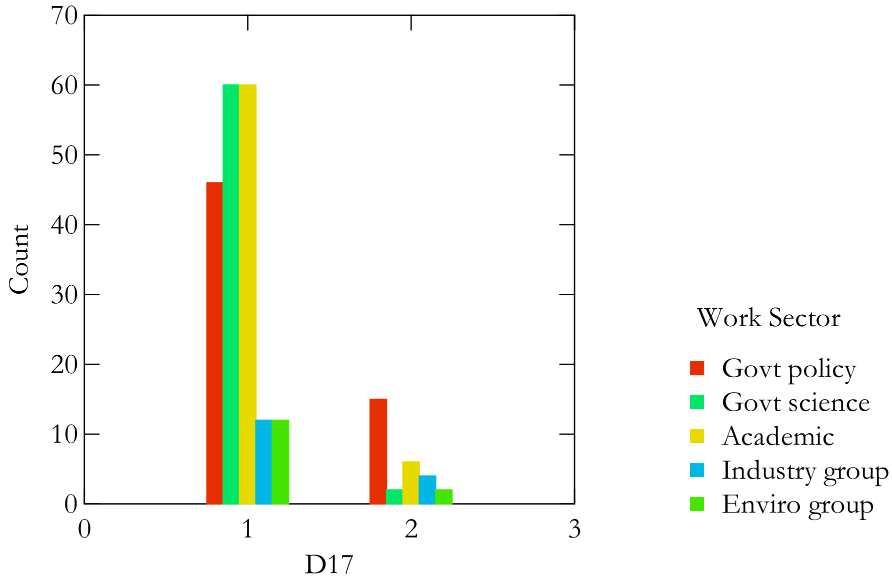
	1 = Yes	2 = No	Total
Frequency	92	121	213
Percentage	43.192	56.808	100

If they indicate an environmental loss will occur if the results are not accepted.



	1 = Yes	2 = No	Total
Frequency	91	121	212
Percentage	42.925	57.075	100

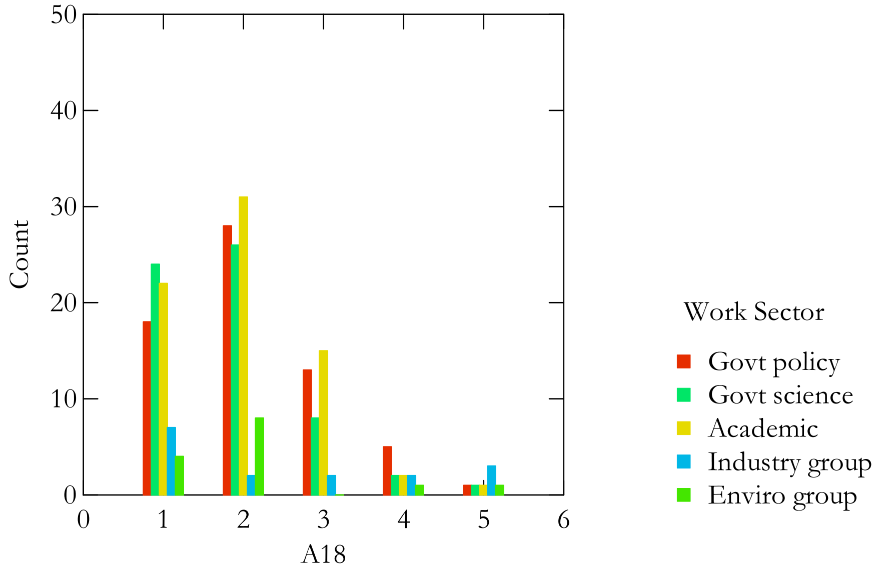
If they do not support a political agenda.



	1 = Yes	2 = No	Total
Frequency	190	29	219
Percentage	86.758	13.242	100

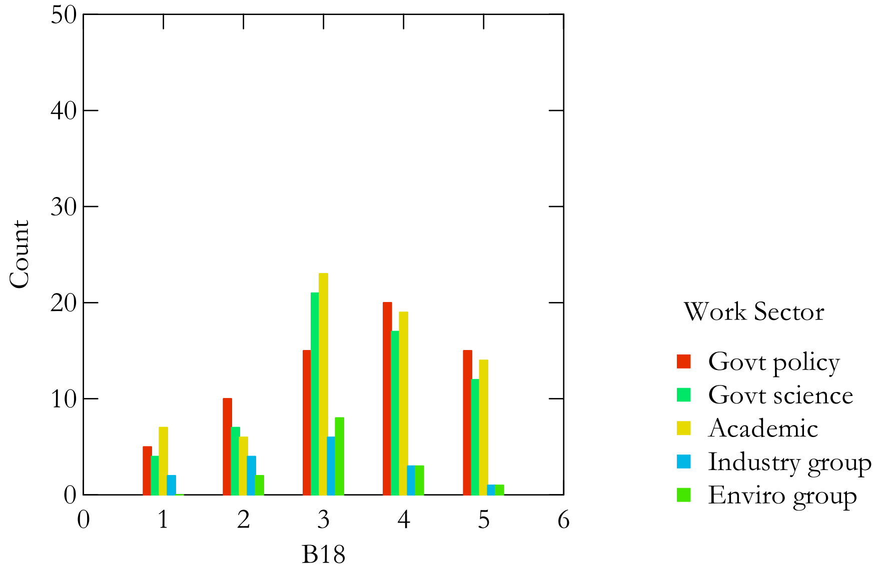
18. Please rank how important the following factors are in determining policy decisions; where 1 = most important and 5 = least important.

Economic



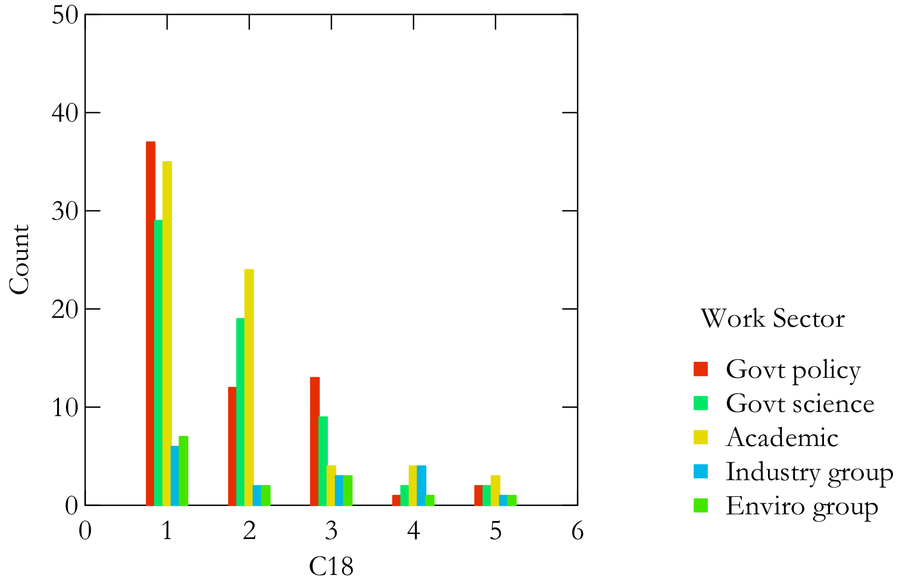
	1	2	3	4	5	Total
Frequency	*75*	**95**	38	12	7	227
Percentage	33.040	41.850	16.740	5.286	3.084	100

Institutional



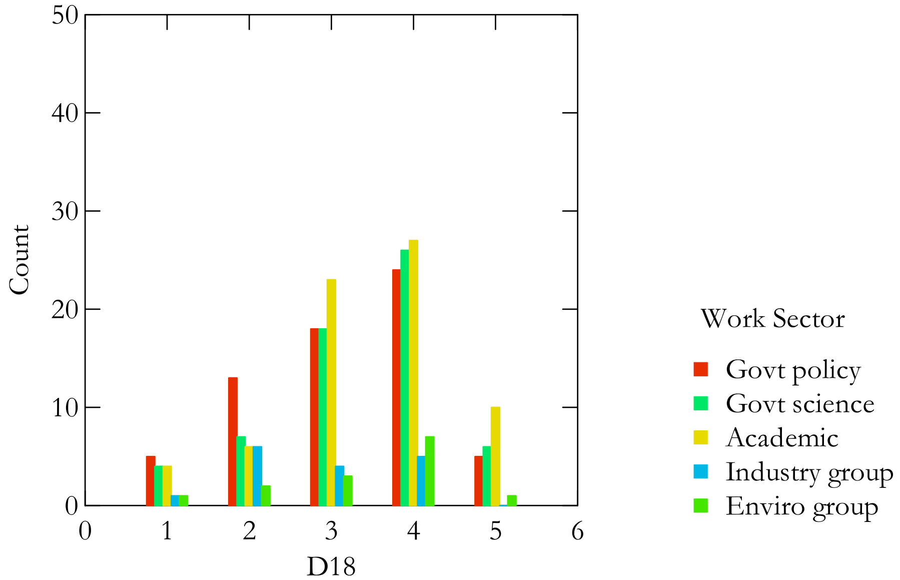
	1	2	3	4	5	Total
Frequency	18	29	**73**	*62*	43	225
Percentage	8	12.889	32.444	27.556	19.111	100

Political



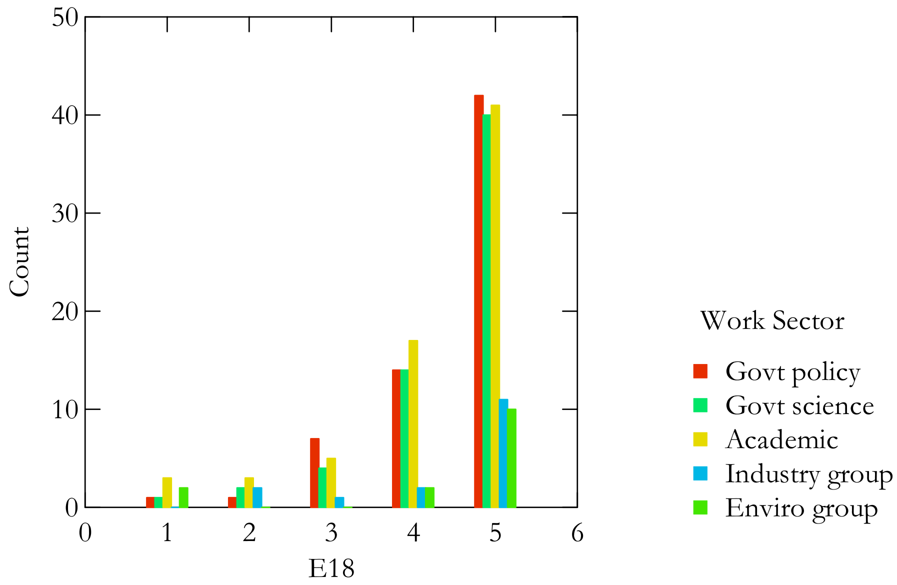
	1	2	3	4	5	Total
Frequency	**114**	*59*	32	12	9	226
Percentage	50.442	26.106	14.159	5.309	3.982	100

Social



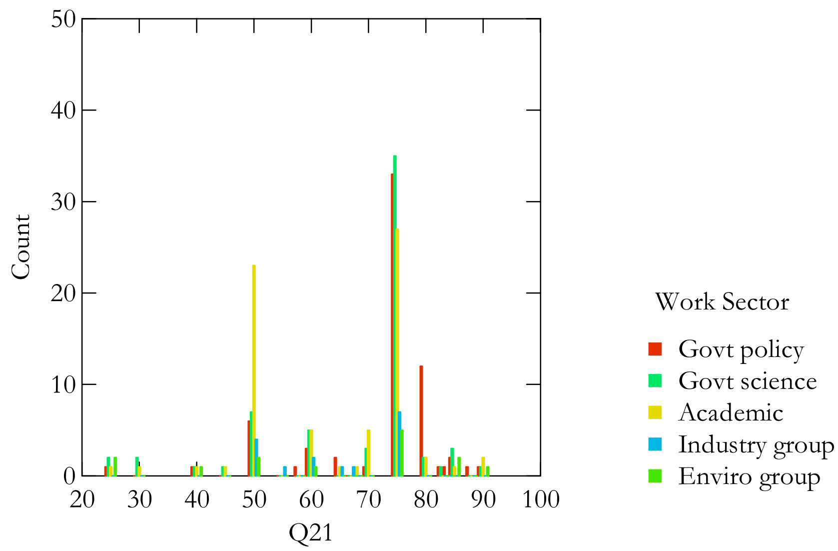
	1	2	3	4	5	Total
Frequency	15	34	*66*	**89**	22	226
Percentage	6.637	15.044	29.204	39.381	9.735	100

Cultural



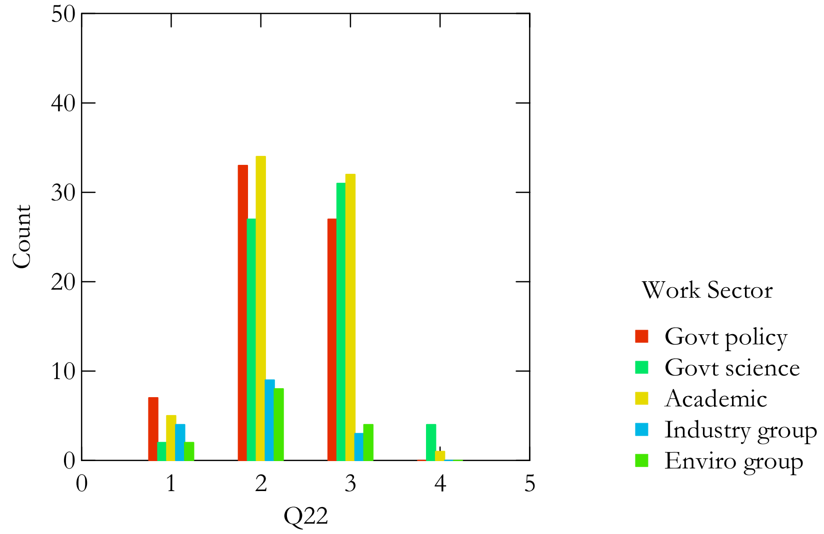
	1	2	3	4	5	Total
Frequency	7	8	17	*49*	**144**	225
Percentage	3.111	3.556	7.556	21.778	64	100

21. If zero represents absolute distrust in scientific research results and 100 represents absolute trust in scientific research results; from the scale-bar below, please indicate (from 0-100) how much you believe the general public, the average person, has trust in scientific research results.



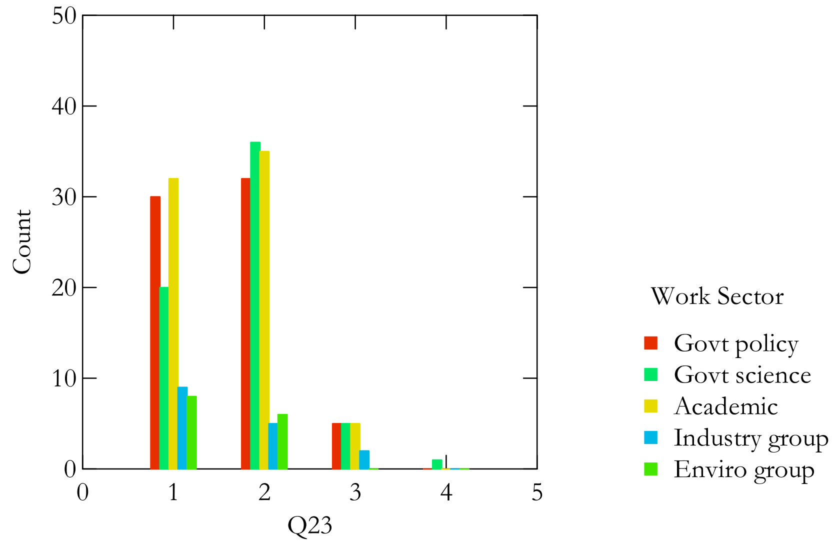
	Total	Minimum	Maximum	Median	Mean	s.e.
Statistics	230	25	90	75	67.222	0.953

22. In your experience of reading scientific papers how often has the language, words, or phrasing used in a scientific paper indicated to you a political position or a personal belief held by the author(s) of a paper? Often = 1 Sometimes = 2 Rarely = 3 Never = 4



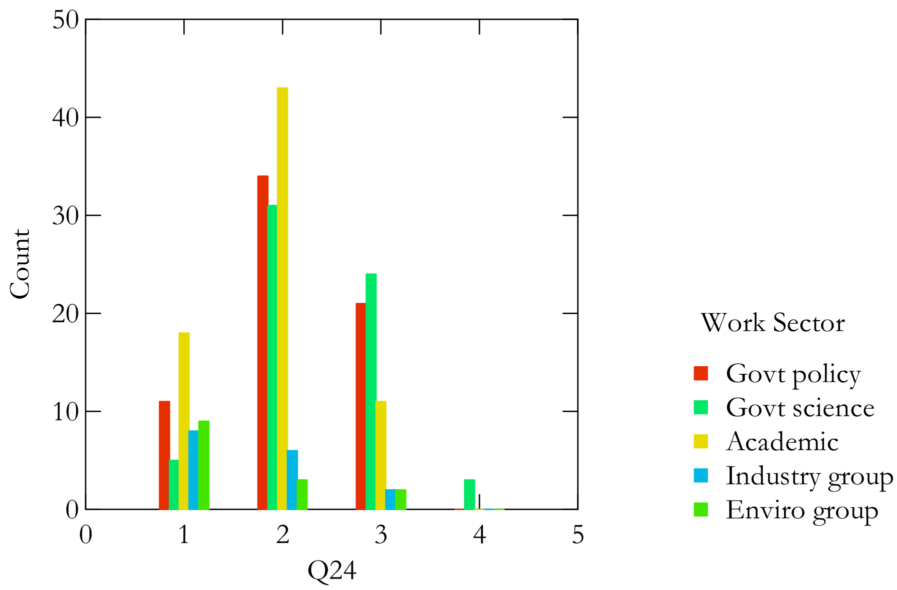
	1	2	3	4	Total
Frequency	20	**111**	*97*	5	233
Percentage	8.584	47.639	41.631	2.146	100

23. In your experience, how often has scientific research that has been commissioned or done by an environment or industry organisation been biased towards that organisation's viewpoint? Often = 1 Sometimes = 2 Rarely = 3 Never = 4



	1	2	3	4	Total
Frequency	*99*	**114**	17	1	231
Percentage	42.857	49.351	7.359	0.433	100

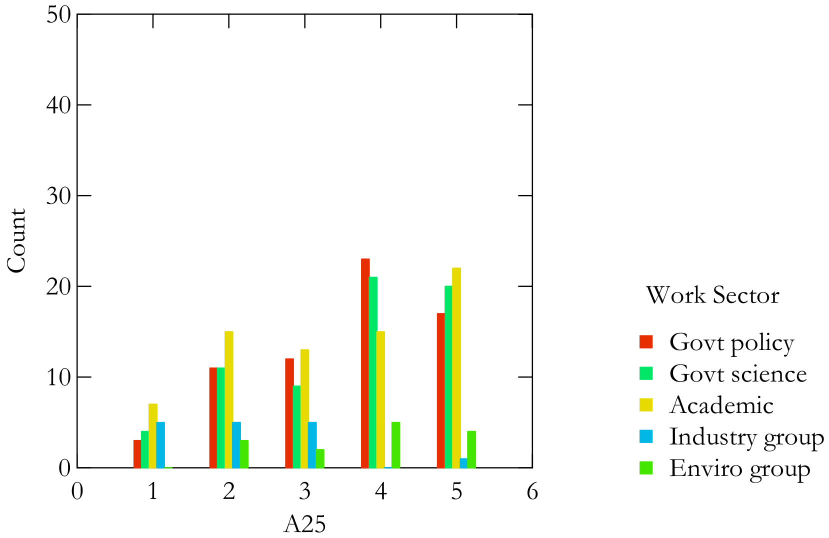
24. In your experience, how often has scientific research that has been commissioned or done by a Government organisation been biased towards that Government organisation's viewpoint?
Often = 1   Sometimes = 2   Rarely = 3   Never = 4



	1	2	3	4	Total
Frequency	51	**117**	*60*	3	231
Percentage	22.078	50.649	25.974	1.299	100

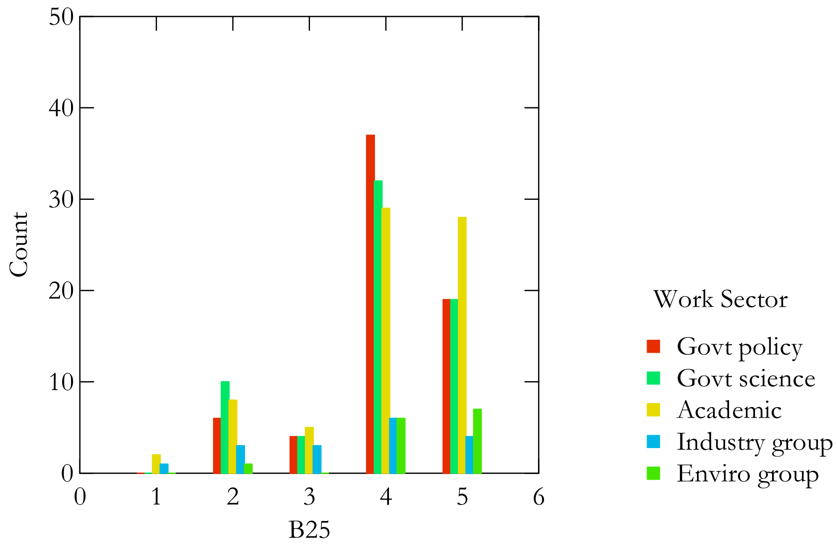
25. Taking a moment to reflect on your personal beliefs about your relationship to the natural world, please circle your level of agreement for the following statements in relation to what you believe; using this scale:
1–strongly agree; 2–moderately agree; 3–neutral; 4–moderately disagree; 5–strongly disagree.

a. The natural world exists for humans to use.



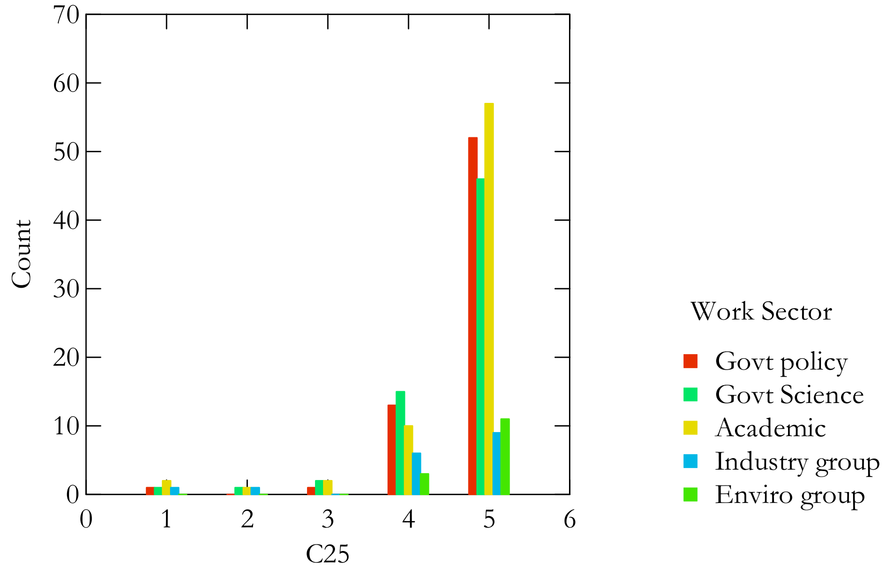
	1	2	3	4	5	Total
Frequency	19	*45*	41	**64**	**64**	233
Percentage	8.55	19.313	17.597	27.468	27.468	100

b. Science will always have a solution for environmental problems.



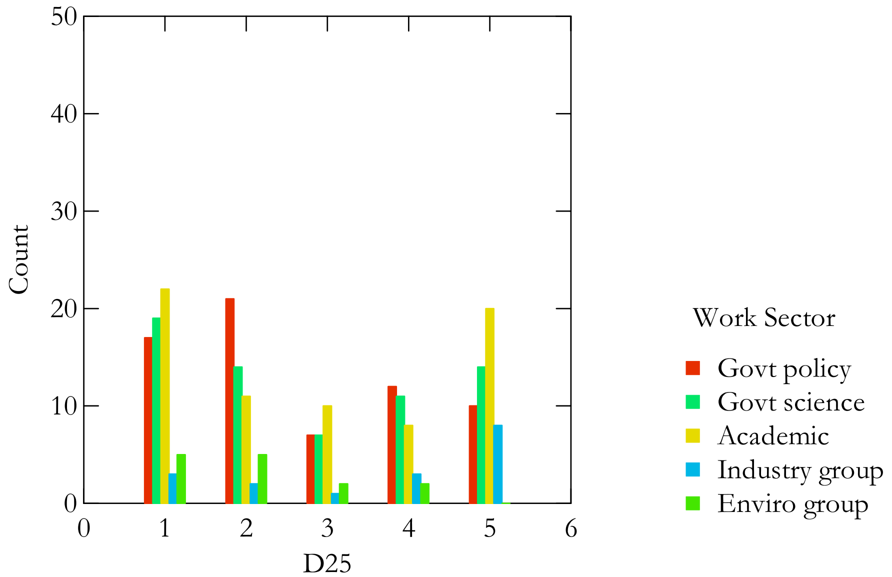
	1	2	3	4	5	Total
Frequency	3	28	16	**110**	*77*	234
Percentage	1.282	11.966	6.838	47.009	32.096	100

c. Humans are separate from nature.



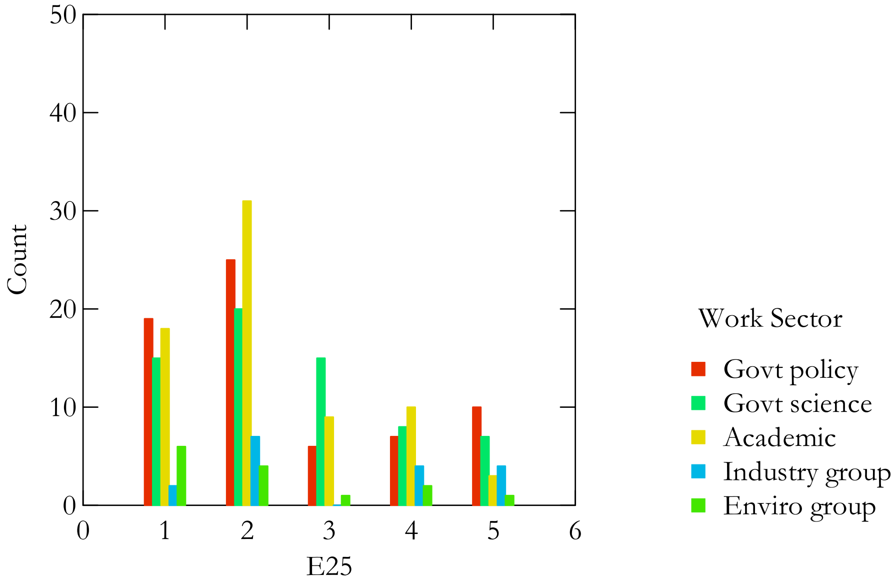
	1	2	3	4	5	Total
Frequency	5	3	5	*47*	**175**	235
Percentage	2.128	1.277	2.128	20	74.468	100

d. Nature exists for itself, independent of humans.



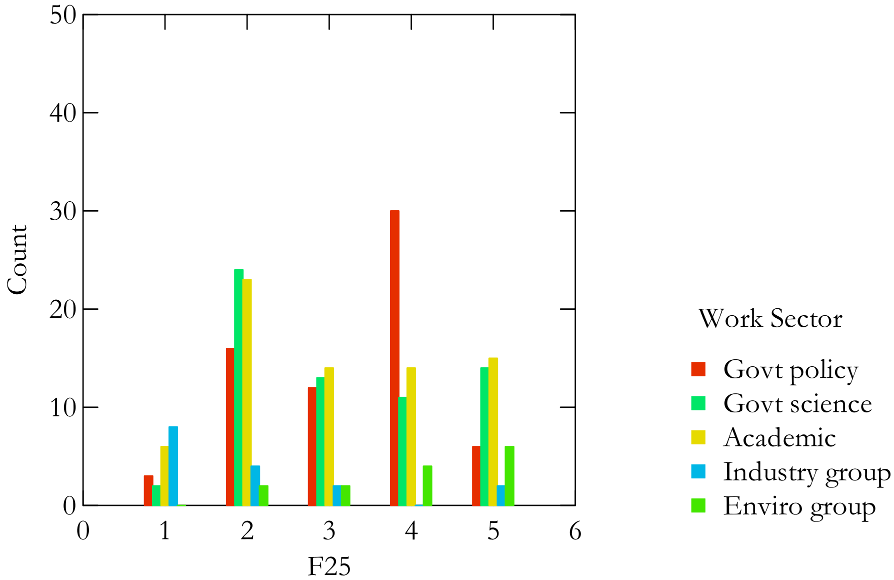
	1	2	3	4	5	Total
Frequency	**66**	*53*	27	36	52	234
Percentage	28.205	22.650	11.538	15.385	22.222	100

e. Humans dominate nature.



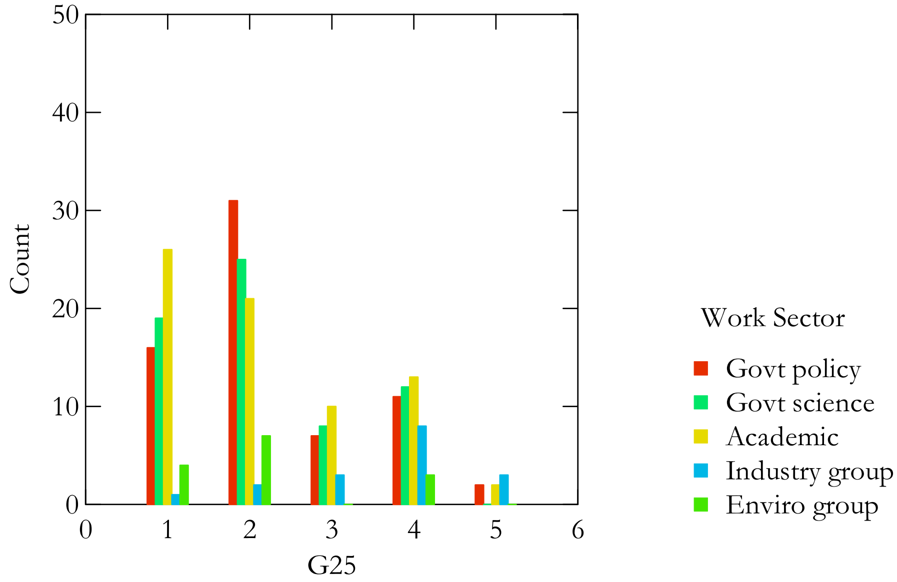
	1	2	3	4	5	Total
Frequency	*60*	**87**	31	31	25	234
Percentage	25.641	37.179	13.248	13.248	10.684	100

f. The environment movement is like a religion.



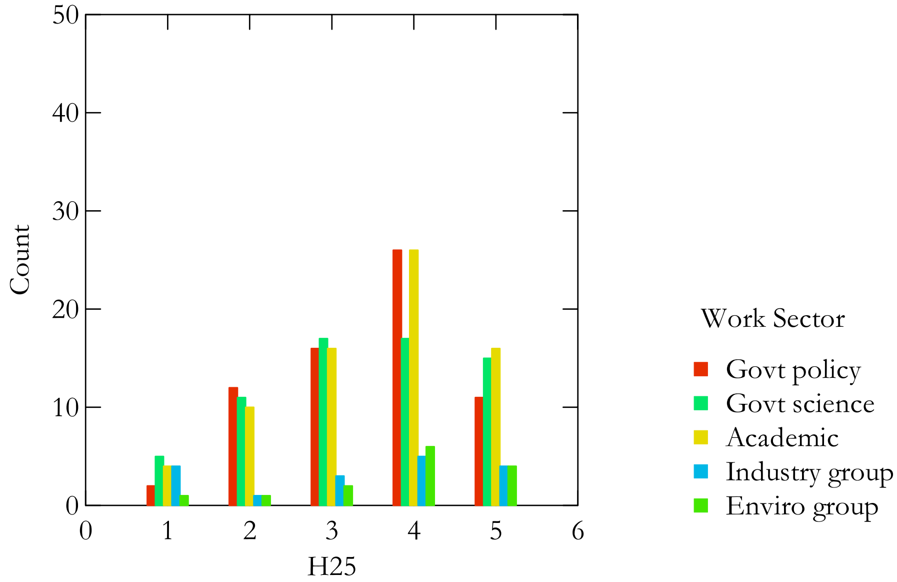
	1	2	3	4	5	Total
Frequency	19	**69**	43	*59*	43	233
Percentage	8.155	29.614	18.455	25.322	18.455	100

g. Human use of nature causes irreversible change.



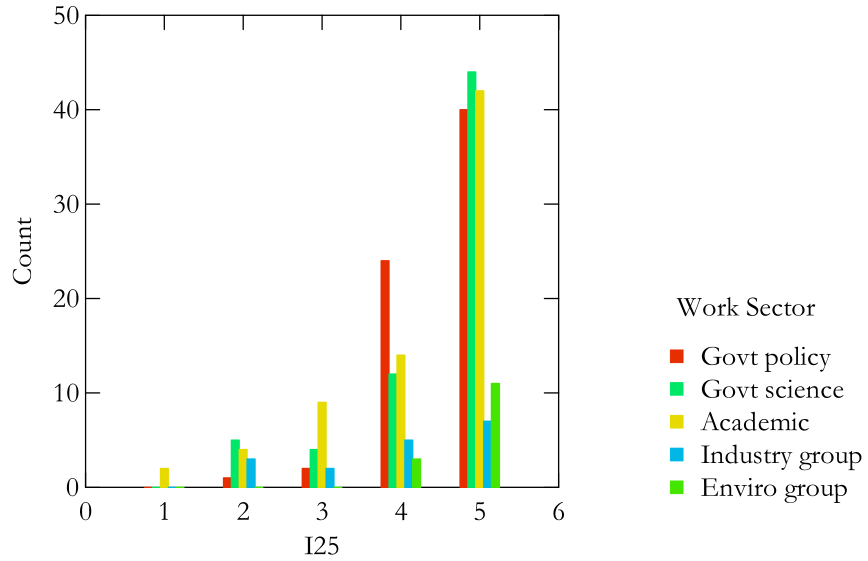
	1	2	3	4	5	Total
Frequency	*66*	**86**	28	47	7	234
Percentage	28.205	36.752	11.966	20.085	2.991	100

h. People come first.



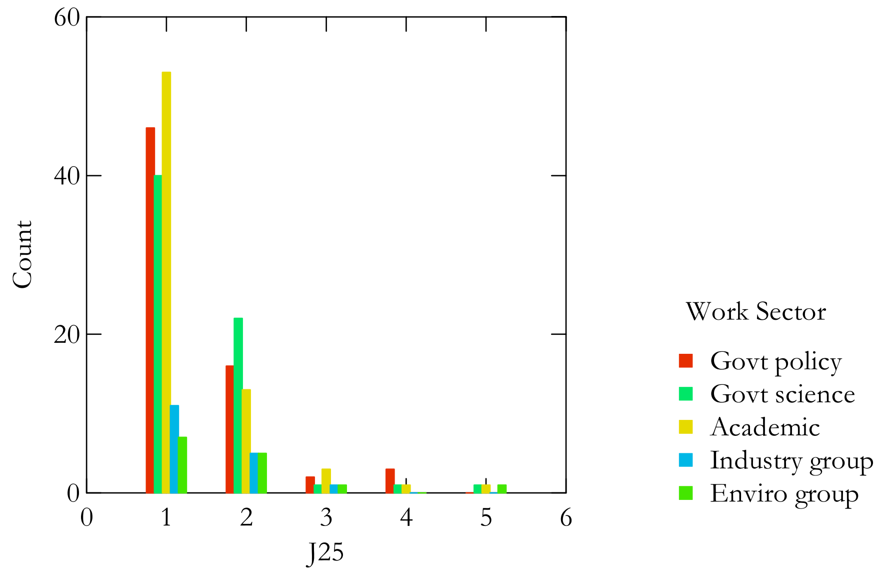
	1	2	3	4	5	Total
Frequency	16	35	*54*	**80**	50	235
Percentage	6.809	14.894	22.979	34.043	21.277	100

i. Nature is a force to be controlled.



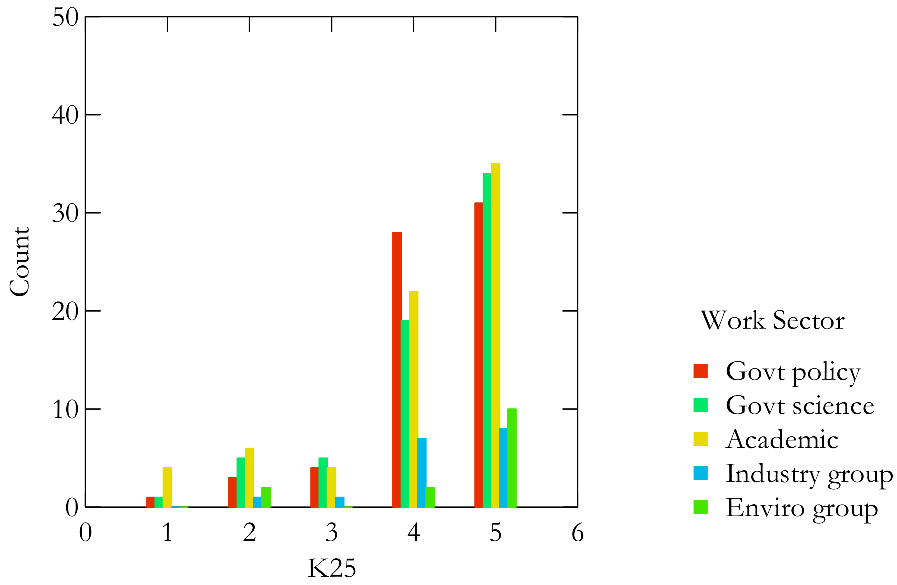
	1	2	3	4	5	Total
Frequency	2	13	17	*58*	**144**	234
Percentage	0.855	5.556	7.265	24.786	61.538	100

j. Humanity is part of nature.



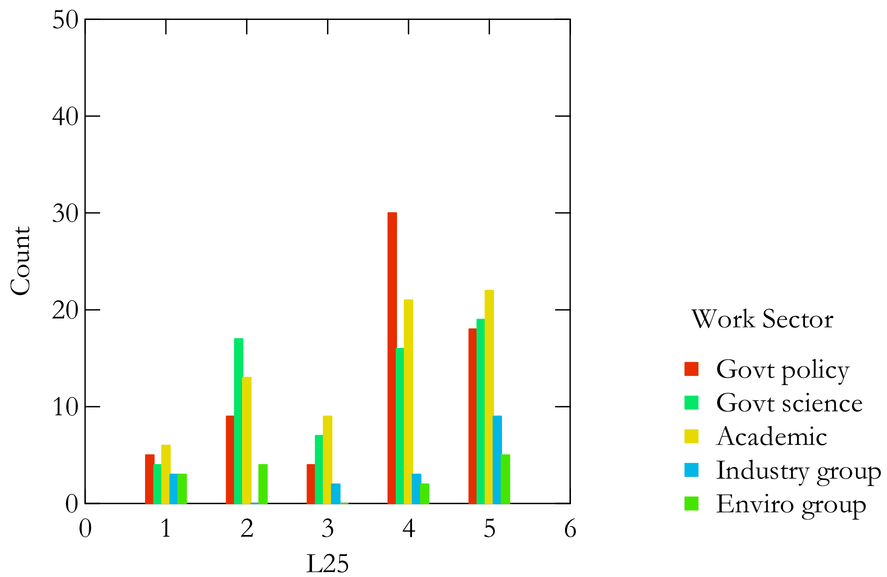
	1	2	3	4	5	Total
Frequency	**157**	*61*	8	5	3	234
Percentage	67.094	26.068	3.419	2.137	1.282	100

k. However humanity uses nature, nature will recover.



	1	2	3	4	5	Total
Frequency	6	17	14	*78*	**118**	233
Percentage	2.575	7.296	6.009	33.476	50.644	100

l. Marine ecosystems are beyond human control.



	1	2	3	4	5	Total
Frequency	21	43	22	*72*	**73**	231
Percentage	9.091	18.615	9.524	31.169	31.602	100

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